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Managing Credit Risk and Emerging Threats: Lessons from the Gaps Revealed by the Pandemic

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Moody's Investors Service (MIS) provides investors with a comprehensive view of global debt markets through credit ratings and research. Moody's Analytics (MA) provides data, analytics, and insights to equip leaders of financial, non-financial, and government organizations with effective tools to understand a range of risks.
Goals for This Session

- Review the gaps in credit models revealed by the COVID-19 Pandemic
- Outline a cohesive credit risk framework that assesses emerging threats, such as cyber risk and supply-chain disruptions
- Review qualitative methods used in fundamental analysis that overcome data challenges inherent in emerging risks
- Use alternative data to describe the varying impact of emerging risks across credit segments
- Live Q&A
Articulating the Impact of Emerging Risks on Credit
An inherent challenge

**Fundamental Analysis**
- Based on analyst’s expertise
- Considers nuanced aspects of each counterparty, along with terms and conditions
- Useful in agency and internal ratings
- Naturally incorporate emerging risks through qualitative overlay

**Limitations:**
- Difficult to update for portfolios with varying characteristics
- Difficult to level set across segments

**Quantitative Credit Models**
- Based on statistical analysis
- Automated and applicable to large portfolios
- Useful as early warning indicator
- Useful with level setting across segments
- Needed for regulatory reporting/accounting

**Limitations:**
- Generic by their nature
- Challenged when environment deviates from historical patterns (emerging risks)
Challenges with Quantifying Emerging Risks

Traditional Expected Credit Loss Models Used in Stress Testing/Impairment

» Economic scenarios are based on models calibrated to experience with broad-brush variables such as unemployment or GDP, and in of themselves cannot differentiate across credit segments or describe emerging risks

» Credit data often segmented coarsely, not allowing for variation in sensitivity to emerging risks

Lessons from COVID-19

» An overlay anchored to traditional models can account for COVID’s unique cross-sectional impact

» That style of overlay can be applied to other emerging risks

Quantifying the cross-sectional impact of emerging risks requires an assessment of:

Segment Granularity

Alternative Data
The Pandemic’s Cross-Industry Impact

Empirical patterns lead to new thinking about granularity & data

Granularity of 121 Industry Segments

FAST FOOD RESTAURANTS and DINE-IN RESTAURANTS are often combined in a single broader sector. To model the Pandemic properly, they must be separated.
The Pandemic’s Cross-Industry Impact

Empirical patterns lead to new thinking about granularity & data

Granularity of 121 Industry Segments

While in the beginning, the AUTOMOTIVE and AIRLINES experienced a similar shock, AIRLINES suffered longer thanks to continued social distancing and travel restrictions. AUTOMOTIVE segment recovered much faster, thanks to improving consumer sentiment.

Naturally, the Pandemic did not have a substantially adverse impact on PHARMACEUTICALS.
Use of Alternative Data to Describe the Pandemic

Cross-Industry and –Country patterns do not follow traditional models

Average of Travel Industries
DINE-IN REST., AIRLINES, HOTELS

Mean EDF
The average levels are aligned.

Unlike in the previous recessions, industry patterns across countries are comparable

AUTOMOTIVE Industry Segment

Mean EDF
The average levels are aligned.

Canada  UK  USA  Germany  France  Japan
Use of Alternative Data

Traditional models cannot capture cross-sectional patterns

Average of Travel Industries
DINE-IN REST., AIRLINES, HOTELS

Mean EDF
The average levels are aligned.

AUTOMOTIVE Industry Segment

Unlike previous recessions, industry patterns across countries are comparable through the pandemic

Mean EDF
The average levels are aligned.

How to differentiate dynamics across industry segments?
Calibrate sensitivities of industry segments to measures of

- Social distancing & the reaction of the population to the Pandemic... MOBILITY INDEX
- Consumer Sentiment...Proxied by EQUITY INDEX
Analytics: Cross-Sectional Overlay
Incorporating observed patterns into credit risk modeling

Launch-off Date

Quarter

Quarter

Quarter

Macroeconomic Scenario
Unemployment Rate, Equity Market, Oil Price, House Prices, Credit Spread Index

Baseline Anchoring →
Macroeconomic shocks to be anchored to a Baseline Scenario

Traditional credit risk model →
Overall impact of the macroeconomic shock on credit risk

Cross-Sectional COVID-19 Overlay →
Varying impact on countries & granular industry segments

Economic recovery →
Are the vaccines effective? When will infections abate?

Initial credit quality
Rating or PD

Google Mobility Index for a country – state of the pandemic and the sociological reaction

Event: Pandemic
Calibrated segment-level parameters using the 2020 data
- Sensitivity to mobility
- Sensitivity to consumer sentiment

PD Projection Under a 96th Percentile Downturn Scenario → Spread of vaccine-resistant variants

Mar 2021
Jul 2021
Oct 2021
Mar 2022
Jul 2022
Nov 2022
Mar 2023

AIRLINES

PHARMACEUTICALS
SEMICONDUCTORS

AUTOMOTIVE

DINE-IN RESTAURANTS

LEISURE & RECREATION


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Cross-Sectional Overlays for Past Crises
This style of analysis can be applied well beyond the Pandemic

**Dot Com Bust**
COMPUTER SOFTWARE experienced an adverse initial shock, in line with the fall in Nasdaq.
Credit risk of AIRLINES increased later and recovered faster, in line with Dow Jones Index.

**Financial Crisis**
REAL ESTATE increased in credit risk that remained elevated for a prolonged period, in line with continued low level of House Price Index
Segments, such as COMPUTER SOFTWARE experienced an increase and then a quicker recovery, in line with Dow Jones Index.
### Lessons from Previous Crises

Overcoming challenges with modeling emerging risks

<table>
<thead>
<tr>
<th>Traditional Quantitative Credit Models</th>
<th>Quantitative Emerging Risks Framework</th>
<th>Fundamental Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Models used for loss projections, IFRS9/CECL, stress testing.</td>
<td>Credit Risk Data&lt;br&gt;Higher frequency, name-level data captures cross-sectional patterns by allowing for empirical analysis with segment granularity descriptive of the emerging risk</td>
<td>Emerging risks, by their very nature, are new threats, for which sufficient historical data does NOT exist</td>
</tr>
<tr>
<td>Based on longer time series of data, at lower frequencies, such as quarterly.</td>
<td>Alternative Data&lt;br&gt;Mobility Indexes&lt;br&gt;Consumer Sentiment&lt;br&gt;Supply chain&lt;br&gt;Vulnerability to cyber events&lt;br&gt;Geo-location of climate hazards</td>
<td>In many cases, a qualitative assessment can be applied consistently across asset classes and is an indispensable part of risk analysis</td>
</tr>
<tr>
<td>Broad-brush economic variables, unable to differentiate industry impact.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Emerging Threats

<table>
<thead>
<tr>
<th>The Global Risks Report 2021</th>
<th>Emerging Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological</td>
<td>Geopolitical</td>
</tr>
<tr>
<td>Cyber Events</td>
<td>Supply-Chain Disruption</td>
</tr>
<tr>
<td>Societal</td>
<td>Enviromental</td>
</tr>
<tr>
<td>Trade Disputes</td>
<td>Infectious Diseases</td>
</tr>
<tr>
<td>Natural Disasters</td>
<td></td>
</tr>
</tbody>
</table>
Fundamental Analysis: Understand Emerging Threats
Upgrades overtaking downgrades; speculative grade default rate to fall

- Rising stars
- Fallen angels
- Upgrades
- Downgrades
- Represent default rate

Building heights represent the global speculative grade default rate on a trailing twelve months basis.

COVID-19 downgrades pick up as the virus spreads around the world.
Some highly exposed sectors still under pressure

<table>
<thead>
<tr>
<th>Sector</th>
<th>% Negative Outlook OR REVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel, Gaming &amp; Leisure</td>
<td>68</td>
</tr>
<tr>
<td>Transportation: Consumer</td>
<td>60</td>
</tr>
<tr>
<td>Automotive</td>
<td>39</td>
</tr>
<tr>
<td>Consumer goods Non-durable</td>
<td>38</td>
</tr>
<tr>
<td>Aerospace &amp; Defense</td>
<td>37</td>
</tr>
<tr>
<td>Global - All Sectors</td>
<td>25</td>
</tr>
</tbody>
</table>

Represents the percentage of issuers within each sector with a negative outlook or under review for downgrade at 30 March 2021.
Four Components to MIS Integration of ESG

New ESG scores will assist in transparently and systematically demonstrating the impact of ESG on credit ratings.

**Credit Ratings & Research**
How is ESG integrated into credit ratings?
ESG factors taken into consideration for all credit ratings. Greater transparency in PRs, as well as Credit opinions. Credit Impact Score (CIS) is an output of the rating process that indicates the extent, if any, to which ESG factors impact the rating of an issuer or transaction.

**ESG Scores**
How is a specific issuer exposed to ESG risks/benefits?
Issuer Profile Scores (IPS) are issuer-specific scores that assess an entity’s exposure to the categories of risks in the ESG classification from a credit perspective. IPSs, where available, are inputs to credit ratings.

**ESG Classification**
What is ESG?
Our classification reports describe how we define and categorize E, S and G considerations that are material to credit quality. New environmental classification sharpens focus on physical climate risks.

**Heat Maps**
Is ESG material to credit quality?
Heat maps provide relative ranking of various sectors along the E and S classification of risks.

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Attacks on global energy infrastructure
….becoming more frequent and disruptive

October 2019 – Attack on India’s largest nuclear facility breaches IT network.


April 2020 – Ransomware attack against Energias de Portugal impacts global IT network.

February 2021 – Eletrobras ransomware attack on IT systems of nuclear power subsidiary.


April 2020 – Attack on Israeli water utility seek to disrupt water supply during COVID epidemic.

June 2020 – ICS-capable SNAKE ransomware attack launched against Enel disrupt corporate networks

May 2021 – Colonial pipeline halts operations after ransomware attack on IT systems.
Oil and gas companies less likely to have completed tabletop simulation exercises than corporate and banking peers, and less likely to perform cyber assessment on third-party vendors.

Moody’s Investors Service, self-reported issuer survey results.

Cyber Risk

Percent of respondents by sector that have completed tabletop simulation exercises since May 2020

Oil and Gas | Aerospace | Real Estate | Chemicals | Gaming | Corporate Finance | Retail | TMT | Business Services | Transportation | Aerospace | Chemicals | Gaming | Real Estate | Corporate Finance | Retail | TMT | Banking

Percent of respondents by sector requiring cyber assessment of third-party vendors

Oil and Gas | Chemicals | Aerospace | Transportation | Gaming | Real Estate | Corporate Finance | Retail | TMT | Banking

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Moody’s Investors Service, self-reported issuer survey results.
Oil and gas industry's cybersecurity investment approaching levels of more advanced banking sector

Cybersecurity spend as percentage of IT/OT budget

Source: Moody's Investors Service, self-reported issuer survey results
Global cyber risk issuer survey – series

SECTOR IN-DEPTH

1 April 2023

Global cyber risk issuer survey – series

SECTOR IN-DEPTH

Electric Utilities – Global

Cybersecurity readiness depends on scale, business model and generation ownership

To some extent, utilities utilize different practices to counter cyber threats, which are often not uniform. In general, utilities have strong cybersecurity programs in place. However, in some instances, cybersecurity programs are not as robust as they could be. Understanding the key differences in cybersecurity practices across the industry is essential for creating an effective cybersecurity strategy.

- Electric Utilities – Global
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- To some extent, utilities utilize different practices to counter cyber threats, which are often not uniform. In general, utilities have strong cybersecurity programs in place. However, in some instances, cybersecurity programs are not as robust as they could be. Understanding the key differences in cybersecurity practices across the industry is essential for creating an effective cybersecurity strategy.
Quantitative Methods for Describing Emerging Threats
## Cyber Events and Their Impact on Credit Risk

Select types of cyber events and sources of the resulting loss

<table>
<thead>
<tr>
<th>Confidential Data Breach</th>
<th>System Failure</th>
<th>Malicious Activity Or Ransomware</th>
<th>Theft of IP or Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Single Company Event</td>
<td>Large-Scale Event</td>
<td></td>
<td></td>
</tr>
</tbody>
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- Disruption of the company's core business
- Recovery costs
- Legal costs
- Damaged reputation
Cyber Events and Their Impact on Credit Risk

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<th>Disruption of the company's core business</th>
<th>Recovery costs</th>
<th>Legal costs</th>
<th>Damaged reputation</th>
</tr>
</thead>
</table>

How can cyber events change the creditworthiness of affected companies?

- Impact EDFs
- Contribute to rating reviews
- Lead to corporate bankruptcies

June 2019: Medical testing giants Quest Diagnostics and LabCorp announced that personal and medical information of about 19.4 million patients had been compromised due to a breach of American Medical Collection Agency (AMCA), their billing collections vendor. Retrieval-Masters Creditors Bureau Inc., which does business as AMCA, filed for Chapter 11 bankruptcy protection.

https://www.forbes.com/sites/taylorarmerding/2019/06/14/more-medical-mega-breaches-thanks-to-third-party-insecurity/?sh=7ce624216111

https://www.moodys.com/research/Moodys-places-SolarWinds-ratings-on-review-for-downgrade-following-announcement--PR_437591

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When do Markets React to Cyber Events?

Using EDFs to quantify the real-time market reaction

What differentiates the magnitudes of impact?

- Confidential data breach (retail customers) in a company’s core business
- Malicious activity: hackers used a SolarWinds software update, and its core business, to access the IT systems of hundreds of customers, ranging from corporations to government agencies
- Confidential data breach (retail customers) in a hotel chain
Quantitative Modeling of a Cyber Event Impact
Challenges: Data sparsity & heterogeneous nature of cyber events

Cyber Event Scenario
- Type & nature of the cyber event
- Translate the cyber event into a shock to a credit risk factor
- Sensitivity of a company or of an industry segment to the cyber event
- Probabilities of default for a credit portfolio under the cyber event

Data & Calibration
- EDF / Asset Return Data
- Accounting Approach – Losses Relative to Company Size
- Other data: equity prices (used in academic literature), CDS, Rating Changes, Defaults
- Alternative Data
- Segment / company data – past incidents, surveys, fundamental analysis
- Qualitative Assessment

Quantitative Credit Model
Projection
### Alternative Data for Cyber Risk

Searching for measures of segments’ sensitivity to cyber events

#### Verizon Dataset of Cyber Incidents
- **32,000 Incidents Over 2020, Global Dataset.**

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>Number of Past Cyber Events</th>
<th>Cost per firm-year Million USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodation</td>
<td>Web Application Compromised: 18</td>
<td>Financial services: 18</td>
</tr>
<tr>
<td></td>
<td>Internal Errors: 15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crimeware: 34</td>
<td></td>
</tr>
<tr>
<td>Administrative</td>
<td>Web Application Compromised: 10</td>
<td>Utilities and energy: 17</td>
</tr>
<tr>
<td></td>
<td>Internal Errors: 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crimeware: 5</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Internal Errors: 0</td>
<td>Technology and software: 14</td>
</tr>
<tr>
<td>Education</td>
<td>Web Application Compromised: 65</td>
<td>Aerospace and defense: 14</td>
</tr>
<tr>
<td></td>
<td>Internal Errors: 62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crimeware: 179</td>
<td>Healthcare: 12</td>
</tr>
<tr>
<td>Entertainment</td>
<td>Internal Errors: 30</td>
<td>Services: 11</td>
</tr>
<tr>
<td>Finance</td>
<td>Web Application Compromised: 152</td>
<td>Industrial/manufacturing: 10</td>
</tr>
<tr>
<td></td>
<td>Internal Errors: 128</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crimeware: 63</td>
<td>Retail: 9</td>
</tr>
<tr>
<td>Healthcare</td>
<td>Web Application Compromised: 140</td>
<td>Information: 11</td>
</tr>
<tr>
<td></td>
<td>Internal Errors: 163</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crimeware: 192</td>
<td>Public sector: 8</td>
</tr>
<tr>
<td>Information</td>
<td>Internal Errors: 162</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crimeware: 403</td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Web Application Compromised: 107</td>
<td>Manufacturing: 10</td>
</tr>
<tr>
<td></td>
<td>Internal Errors: 47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crimeware: 393</td>
<td></td>
</tr>
<tr>
<td>Mining+Utilities</td>
<td>Internal Errors: 16</td>
<td>Retail: 8</td>
</tr>
<tr>
<td>Other Services</td>
<td>Web Application Compromised: 39</td>
<td>Public sector: 8</td>
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<tr>
<td></td>
<td>Internal Errors: 20</td>
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<tr>
<td></td>
<td>Crimeware: 15</td>
<td></td>
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<tr>
<td>Professional</td>
<td>Internal Errors: 139</td>
<td>Transportation: 7</td>
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<tr>
<td>Public</td>
<td>Web Application Compromised: 149</td>
<td>Consumer products: 7</td>
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<tr>
<td></td>
<td>Internal Errors: 112</td>
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<tr>
<td></td>
<td>Crimeware: 800</td>
<td>Communications: 7</td>
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<tr>
<td>Real Estate</td>
<td>Internal Errors: 14</td>
<td>Life science: 6</td>
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<td>Retail</td>
<td>Web Application Compromised: 66</td>
<td>Education: 5</td>
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<td></td>
<td>Internal Errors: 21</td>
<td></td>
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<tr>
<td></td>
<td>Crimeware: 55</td>
<td>Hospitality: 5</td>
</tr>
<tr>
<td>Transportation</td>
<td>Internal Errors: 22</td>
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<td></td>
<td>Crimeware: 15</td>
<td></td>
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#### Ponemon Survey (2017) Annualized Cost of Cyber Crime, Global Sample, 254 organizations

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<td>Hospitality</td>
<td>5</td>
</tr>
</tbody>
</table>

### MIS – Cyber Risk Heatmap (2019) Qualitative Assessment

<table>
<thead>
<tr>
<th>Sector</th>
<th>Vulnerability</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitals</td>
<td>HIGH</td>
<td>HIGH</td>
</tr>
<tr>
<td>Medical Devices</td>
<td>HIGH</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>Banks</td>
<td>HIGH</td>
<td>HIGH</td>
</tr>
<tr>
<td>Basic Commodities</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Consumer Products</td>
<td>MEDIUM</td>
<td>LOW</td>
</tr>
<tr>
<td>Lodging, Gaming</td>
<td>HIGH</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>HIGH</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>Oil &amp; Gas</td>
<td>LOW</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>

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Quantifying a Cyber Scenario
Cross-sectional impact of a large-scale attack on credit

Cyber scenario calibrated to three times WannaCry or Not Petya ransomware attacks

- The segments with the most pronounced PD shocks include HEALTHCARE and FINANCE
- On the other hand, segments such as REAL ESTATE see little impact

Projected Annualized Cumulative PD

- Resiliency of companies that recover from the cyber event

Launch-Off Date
Quarter 1
Quarter 2
Quarter 3
Quarter 4

Accommodation
Construction
Education
Entertainment
Finance
Healthcare
Information
Manufacturing
Mining+Utilities
Professional
Real Estate
Retail
Transportation
Quantifying Emerging Threats: Climate Hazards
Natural disasters and affected firms post-event excess asset returns

Credit Assessments and Emerging Threats
By their nature require articulation using alternative data
Credit Assessments and Emerging Threats
By their nature require articulation using alternative data

“if you’ve seen one pandemic, you’ve seen … one pandemic.” Adam Kucharski
Q & A