

MOODY'S

Risk^N

The Era of Exponential Risk

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FOREWORD

The Era of Exponential Risk^N

Rob Fauber, President & CEO



In conversations with leaders in business, government, and financial markets, I hear a common theme.

The world has grown incredibly complex. Risk has grown more complex. Supply chain failures; cyberattacks; geopolitical tensions; sanctions and security issues; and extreme weather events — all playing out against a backdrop of economic uncertainty and social unrest.

It's clear: we're now living in a new era. The Era of Risk^N – Exponential Risk.

We're linked by technology and trade, by culture and commerce. This means that risks no longer exist in isolation. As organizations and nations are linked, so too are the risks they face.

For leaders, understanding the new era is imperative: resiliency and sustainable value creation depend on recognizing and adapting to Exponential Risk. And it's an opportunity — not just to understand Exponential Risk, but to get ahead of it.

The past few years alone have brought into focus how our interconnected world creates

new, compounding risk.

A military conflict creates a cascading series of risks, from energy insecurity and commodity disruptions to rising inflation and a refugee crisis. A ransomware attack directed at an oil pipeline leads to widespread goods shortages. A devastating weather event shuts down vital supply chains.

The old ways of managing risks — as one-offs, in silos — no longer cut it. We need a new mindset that drives growth by understanding Risk^N – Exponential Risk through a growing body of knowledge and increasingly powerful analytical tools.

Like the shift from analog to digital, from agricultural to industrial, the new Era of Exponential Risk is here to stay. With the right perspective, leaders can more than meet the Risk^N – Exponential Risk moment: they can anticipate, adapt, and ultimately thrive in this new era.

PART 1

Navigating the New Era of Risk^N

We're living in a new era

One where the nature of risk has fundamentally changed.

For decades — centuries, even — organizations faced different forms of risk. They sought to understand those risks. To anticipate them. Prevent or mitigate them. Build resilience. And unlock the opportunity on risk's flip side.

New risks emerged over time. Each new risk that appeared on the scene was studied and gradually understood. Resources were applied against the risk, models built. The number of risks may have multiplied, but the underlying

This is the new era: the Era of Risk^N — Exponential Risk

formula largely stayed the same.

What happens, though, when individual risks begin to feed off each other? When one risk meets

and multiplies another risk — to produce an entirely new set of challenges, often unforeseen?

Now structural trends like globalization, digitization, fragmenting regulatory environments, climate change, and changing consumer expectations are colliding with low probability, high-severity flashpoints.

And it's creating challenges locally, nationally, and internationally — across digital, physical, and sector operating environments.

Organizations, sovereigns, and market participants must now contend with cyberattacks, operational failures, supply chain bottlenecks, growing geopolitical tensions, and environmental and social pressures.

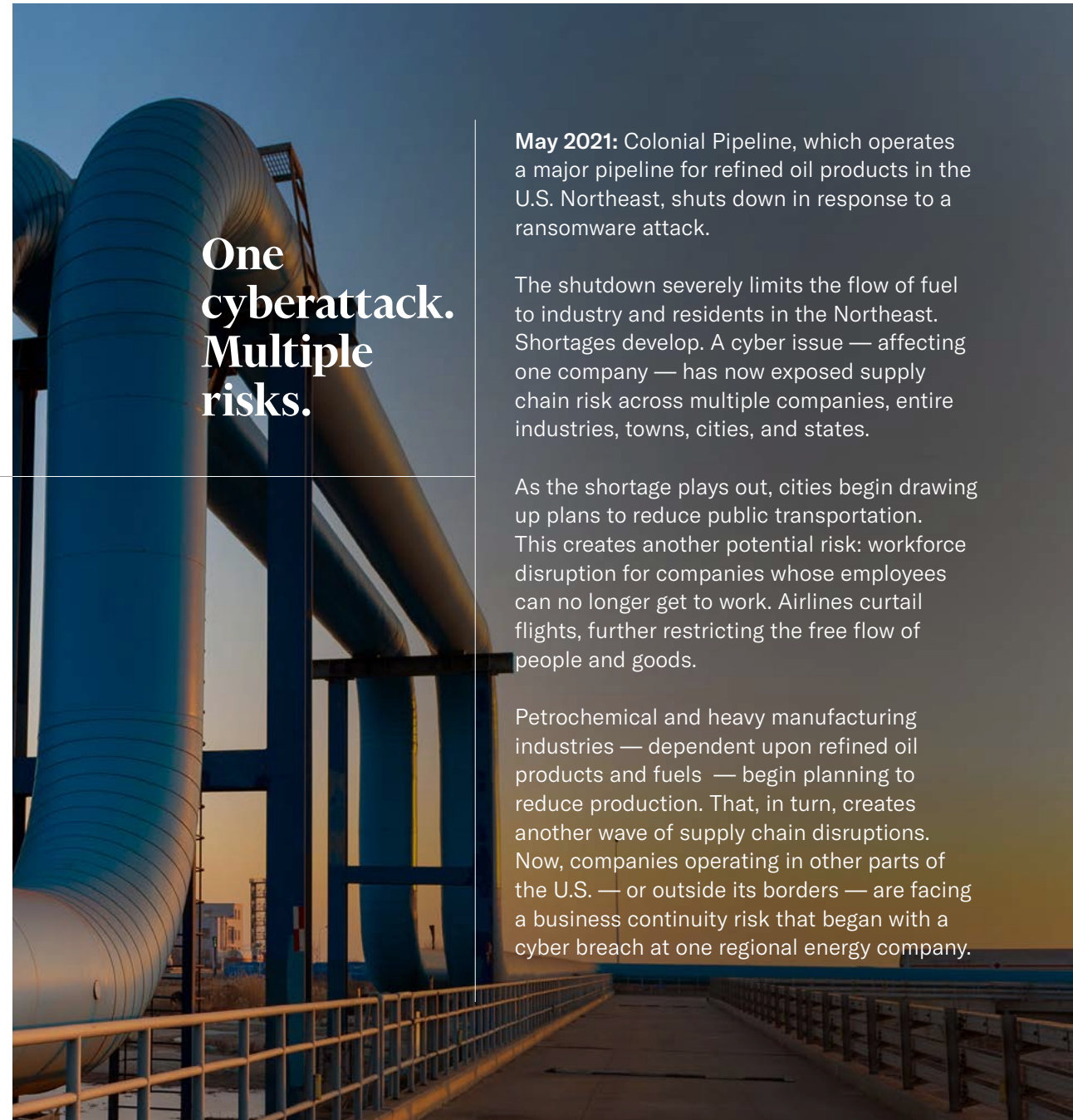
One cyberattack. Multiple risks.


May 2021: Colonial Pipeline, which operates a major pipeline for refined oil products in the U.S. Northeast, shuts down in response to a ransomware attack.

The shutdown severely limits the flow of fuel to industry and residents in the Northeast. Shortages develop. A cyber issue — affecting one company — has now exposed supply chain risk across multiple companies, entire industries, towns, cities, and states.

As the shortage plays out, cities begin drawing up plans to reduce public transportation. This creates another potential risk: workforce disruption for companies whose employees can no longer get to work. Airlines curtail flights, further restricting the free flow of people and goods.

Petrochemical and heavy manufacturing industries — dependent upon refined oil products and fuels — begin planning to reduce production. That, in turn, creates another wave of supply chain disruptions. Now, companies operating in other parts of the U.S. — or outside its borders — are facing a business continuity risk that began with a cyber breach at one regional energy company.




 RANSOMWARE X SUPPLY CHAIN


 CLIMATE X BUSINESS CONTINUITY


 CYBER RISK X AUTOMATED AGRICULTURE



 INFLATIONARY PRESSURE X CREDIT RISK

Examples of Exponential Risks

Organizations and nations now find themselves increasingly vulnerable to a risk “domino effect.” A single risk, affecting a single company or country, that triggers other risks over time — both within the entity itself and beyond.


 SUPPLY CHAIN X SOVEREIGN DEBT


 ENERGY INFLATION X COMMERCIAL REAL ESTATE


 ETHICAL RISK X SUPPLY CHAIN


 GOVERNANCE X COUNTERPARTY RISK

As organizations, economies, and nations have become more intertwined, risk itself has evolved

Rare is the risk that exists in isolation. Any risk — large or small, new or longstanding — likely connects to other forms of risk. And the aggregate risk can be much greater than the sum of its parts — with cascading effects for creditworthiness, access to capital, insured and uninsured losses, valuation, and profitability.

The result for companies and countries that are caught out: surprise, disruption, and loss. But for those who anticipate and act quickly, the Era of Exponential Risk promises a new era of opportunity.

In a single week in 2022, Moody's sent more than 9,000 alerts on supply chain vulnerabilities, ranging from fraud to human trafficking risk, that could affect companies' bottom lines and licenses to operate.

For leaders, this new form of risk creates a fresh set of considerations: the need to look at risk in a different way.

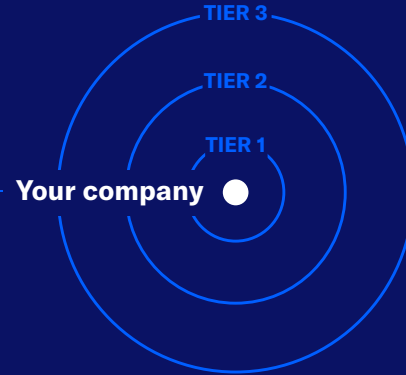
- 1 | How might individual risks feed off each other?
- 2 | What remote risks lie deep within a network of suppliers or partners?
- 3 | How do we decode risk, even as we forge more connections and grow even more intertwined with others in our ecosystems?
- 4 | How do we build resilience, not against one shock alone, but against multiple shocks at once?
- 5 | Where can we uncover and unlock opportunity to get ahead of the competition?



How risk grows exponentially across the value chain

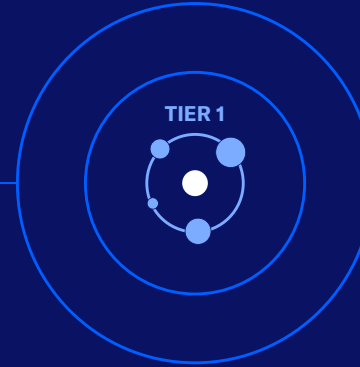
1. INTERCONNECTED SUPPLY CHAIN

Based on a supplier's closeness to your business or your final product, there are likely multiple tiers of suppliers within your supply chain.



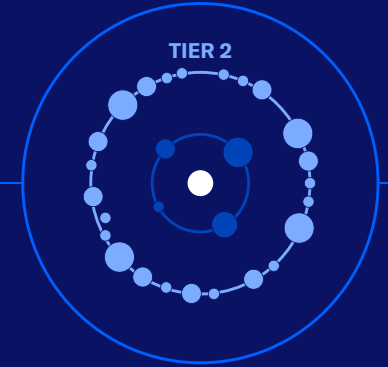
2. TIER 1 SUPPLIERS

These are your closest partners that directly conduct business with you, including contracted manufacturing facilities or production partners.



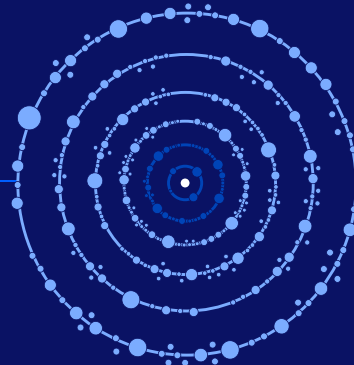
3. TIER 2 SUPPLIERS

The next layer of suppliers or subcontractors serve as a source for where your Tier 1 suppliers get their materials.



4. TIER 3 AND BEYOND

Additional tiers — further removed from your organization — are still connected to your business and can expose you to risk.



5. VALUE CHAIN RISK

Knowing your supply base is fundamental to minimizing risks, which can occur further down the supply chain where they might not be immediately apparent.



6. RISK^N – EXPONENTIAL RISK

Each organization in the value chain has a unique risk factors – from cybersecurity to human rights, physical climate risk to sanctions, and credit to geopolitical pressure.



Risk events in one value chain can exponentially spread

It is convenient to evaluate risk in silos and daunting to consider all the complex interactions; in a reasonably stable world, that may have been sufficient. Today, that's not enough. In this new era, though detailed analysis of individual risks remains necessary, evaluating the interactions between risk domains has become imperative.

Leaders now need to base their decision making on a 360-degree view of what's coming next, getting ahead of emerging risks to build resilience, fully understanding their supply chain and customer base, and protecting and creating growth opportunities. They need to be able to see both the trees and the forest.

Thankfully, leaders now have access to a level of risk assessment and understanding that was unavailable to anyone as recently as five years ago. Massive data sets, powerful computing, and a growing understanding of exponential risk, together, provide — for the first time — a detailed view of Risk^N — Exponential Risk.

Looking ahead, it's clear: this new era isn't going to fade away. In fact, the number of risks — and the ways they interact with each other — will multiply. For those in c-suites, boardrooms, or seats of government, understanding exponential risk has become a necessity.

Smart decisions in the Era of Risk^N

How leaders can navigate Exponential Risk



Separate out the signal from the noise by accessing larger data sets — beyond your own organization — to focus on high-impact and interconnected risk areas.



Break down risk planning silos by bringing different teams together to explore overlapping risks and emerging issues.



Identify any single points of failure — such as a facility, software, or component — and bulk up resiliency and redundancy.



Create a poly-crisis team equipped and empowered to act decisively in the face of multiple shocks.

Top Exponential Risks:

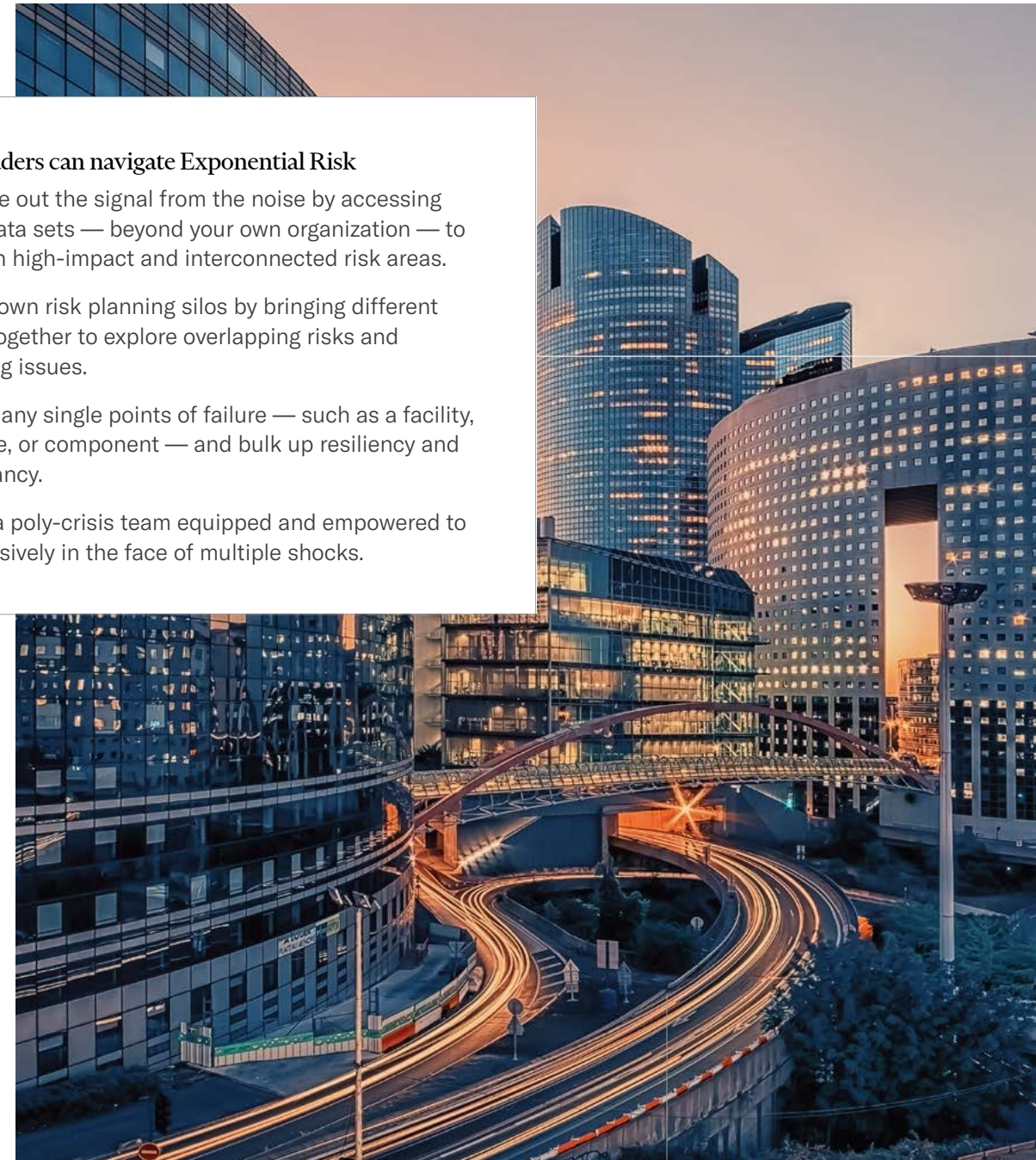
Geopolitical Instability

Inflationary Pressures

Cyberattacks

Extreme Weather Events

Supply Chain Disruptions



Risk[™] in action

Baby formula

SUPPLY CHAIN X EXTREME WEATHER



The 2022 disruption of Abbott Nutrition's baby formula plant in Sturgis, Michigan demonstrates the impact of exponential risks. At the start of 2022, the industry was under production pressure due to materials shortages and pandemic-related supply chain issues. By May 2022, 43% of formula products were out of stock nationwide.¹ In June, an extreme weather event hit the Sturgis facility, forcing it offline.

The failure of a single plant quickly became a national challenge for families and the Biden administration, as out of stock rates hit 90% or more in 10 U.S. states. Abbott faced compounding risks with financial impacts for customers, suppliers, commercial real estate companies, insurers, and banks.

Source: ¹Bloomberg - One in Five US States Is 90% Out of Baby Formula - June 2022

Out of stock rates for formula products hit **90% or more** in **10 U.S. states**.



More and more management teams want to understand their exposure to extreme weather risk — across their operations and right down to the individual facility level. By bringing together historical and predictive data streams with natural catastrophe risk modeling, organizations can build resilience and make better business planning decisions that protect and enhance value.

– **Robert Muir-Wood**
Chief Risk Officer, Moody's RMS

PART 2




The New Risk Landscape

What makes this new era even more challenging?

Interconnected risks are often too difficult to spot in the early stages. Multiple recent “black swan” generational events — the Covid-19 pandemic, Russia’s invasion of Ukraine — started off as risk “noise,” with little hint of their future impact, ability to trigger other risks, or potential for cascading effects.

What defines the Era of Risk^N ?

It is driven by several factors:

-  The interconnected web of relationships that most — if not all — organizations and nations now possess. Rarely does any entity operate in isolation.
-  The underlying shared platform connectivity that links us all. There is system-wide interdependence: we need each other to perform the functions of our respective organizations. And technology interdependence: we are linked — by software, system integration, or basic electronic communication — to each other.
-  The multi-dimensional nature of newer risks — like cyber, supply chain, or extreme weather events — that thrive in an interdependent environment.

The result: Organizations and nations now find themselves increasingly vulnerable to a risk “domino effect.” A single risk, affecting a single company or country, that triggers other risks over time — both within the entity itself and beyond.

The new vocabulary of Exponential Risk

Given their complex, multi-dimensional nature, no two risk areas are exactly alike. And exponential risks often fall into one of the below categories.

Sequential Risk

Definition: A single event triggers multiple secondary risks:

Risk¹ → Risk² → Risk³

EXAMPLE

The Suez Canal obstruction: A container ship runs aground and unleashes a series of risk events, cutting across multiple areas:



Supply chain disruption



Banking and financial losses



Consumer goods prices

Swelling Risk

Definition: Two or more risks unexpectedly converge and cause a networked, cascading effect:

Risk x Risk

EXAMPLE

Risk #1 – Cyber: A one-off ransomware attack shuts down a large, cyber-vulnerable grain co-op — causing the operation to go offline.

Risk #2 – Stretched supply chains: Pressured to maintain high margins, meat producers run lean, just-in-time supply chains — with little redundancy or extra capacity.

Impact – The halting of grain (animal feed) — a cyber risk with one company — collides with downstream, vulnerable supply chains to create an industry-wide issue with implications for an entire system.



PART 3

Meeting the Challenge of Risk^N

The
interconnectedness
of Risk^N as well as
the volatility it
creates – is
unprecedented

But market participants have never been in a better place to identify, understand, and mitigate these threats.

Meeting the challenge, however, requires both advanced data and technology and, often, organizational behavior change.

Moody's is bringing together multiple data sets to assess emerging risks and building risk analysis tools across multiple factors.

Historically, organizations studied and managed risks in silos, defined by the risk area in question or the expertise it required. The supply chain team managed risks within the supply chain. The office of the CIO managed cyber risk.

As new risks emerged, companies assessed data and analysis to understand those risks. They added in-house expertise to manage those risks. But the risks still remained siloed, dealt with largely on their own.

Now, as leaders witness or experience the impact of exponential risk, they are breaking down their own internal silos that can limit the ability to see, understand, and address these threats.

Cross-risk threat analysis and mitigation are now best practice. The focus is less on the individual risk and more on potential combinations.

The complexity and vastness of Risk^N – Exponential Risk means that an unprecedented level of intelligence and insight is required.

That's now possible thanks to massive third-party data sets built around complex relationships and supply chains, powerful analytical tools able to unlock deep insights, and a growing body of knowledge drawn from one real-time example after another.



Getting the data right

Effective integrated risk analysis defines a common language and framework for a wide variety of risk factors and their potential financial impact.

It then translates events into probabilities of default and loss, and analyzes how risks interact and compound over time — and how that affects financial performance from valuation to cash flow and return on investment.

It works at both asset and portfolio level, allowing organizations and nations to understand their exposure and swap out riskier assets.

As demand to understand Exponential Risk

As demand to understand exponential risk grows, Moody's is bringing together multiple data sets to assess emerging risks and building risk analysis tools across multiple factors that are both backward — and forward-looking — modeling what could result after an event has occurred and predicting what could result if an event were to occur.

Where to start?

To navigate Risk^N, leaders should first probe the following areas

VALUE CREATION

Which established and emerging risk factors are most financially relevant?
How will those material risks evolve and change over time?

VALUE CHAIN

How can we know who we are working with in developing and delivering our products and services — both directly and indirectly? Can we map our entire supply and value chains out to the furthest tiers?

What are the risk profiles of the organizations we're serving and/or partnering with? Can we map our entire customer base?

DATA

What data reporting systems do we have to help our leaders make integrated risk assessments and evaluate long-term plans?

Do we have trusted and verifiable data sources on our risk exposure?

Do we have an effective system to combine multiple risk data inputs, and to interpret the potential up and downsides?

DASHBOARDS

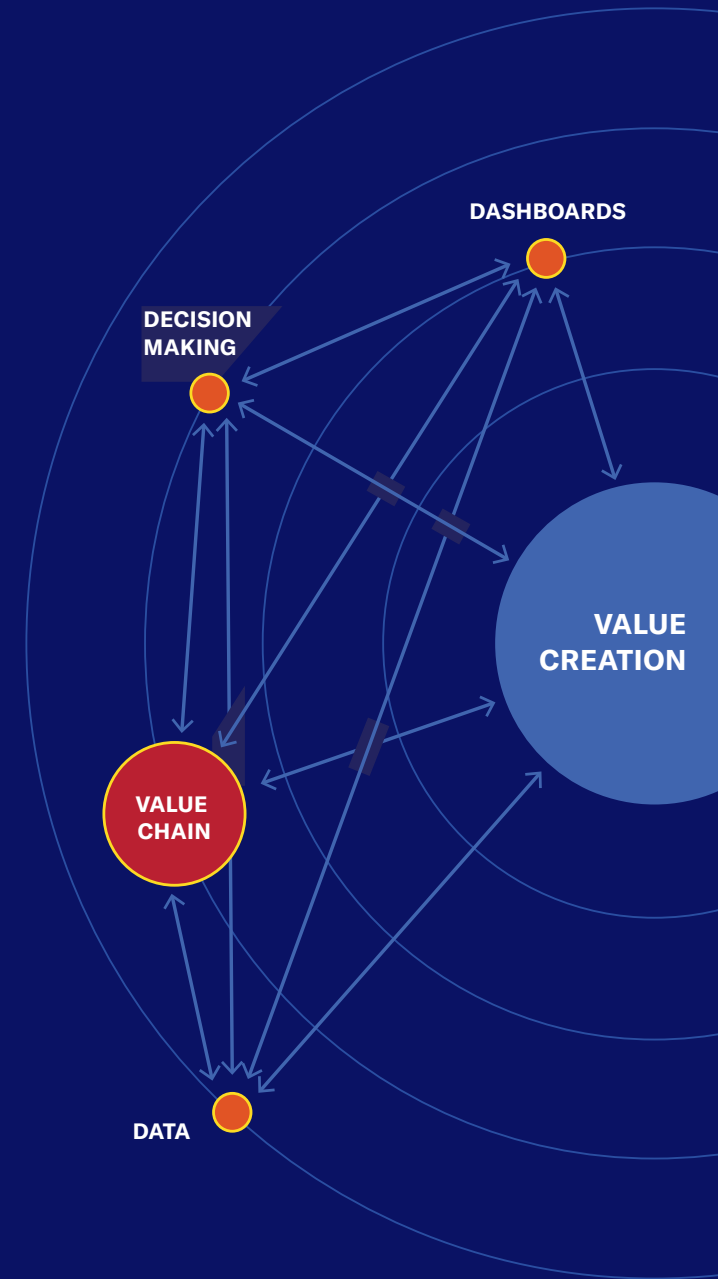
What is our early warning system for new outside threats that could create contagion effects, including public health risk, armed conflict, and social unrest?

What mechanisms do we have to flag and escalate potential flashpoints?

DECISION MAKING

How are we learning from past experiences and making real-time decisions based on reliable data?

What processes do we have in place to model and predict potential risks and opportunities with a strong degree of accuracy?



Risk[™] in action

Cybersecurity

GEOPOLITICS X CYBERCRIME X OPERATIONAL DISRUPTION



Cyberattacks are increasing in frequency: up by 15% in 2021 compared to the previous year,⁶ with implications for nation states, economic sectors, and individual companies.

NATION STATE ATTACKS

In 2022, Albania blamed the Iranian administration for multiple cyberattacks on its national systems, which led to geopolitical risk as the Albanian government considered invoking NATO's Article 5, where an attack against one member is an attack against all.

SECTOR ATTACKS

\$22 trillion — or 28% of the \$80 trillion — in collective debt rated by Moody's across 71 global sectors has high or very high cyber

risk exposure, an increase of \$1 trillion since 2019.⁷ Moody's Investors Service scored critical infrastructure sectors such as electric, gas and water utilities, and not-for-profit hospitals as very high risk.

COMPANY ATTACKS

As the agricultural industry becomes more technologically advanced, there is a higher risk of cyber criminals targeting agribusiness. In 2020 and 2021, there were several major cyber incidents in the sector, which resulted in the FBI releasing a notice warning agricultural businesses to be alert and that farming cooperatives are particularly susceptible to cyberattacks, as a successful attack would have had profound knock on effects for consumer prices and community wellbeing.

\$1 trillion increase between 2019 and 2022 in the collective debt rated by Moody's which has 'high' or 'very high' exposure to cyber risk.

Source: ⁶MIS Cyber heat map: Risks are rising, but many sectors are boosting defensive capabilities - September 2022
⁷MIS Cyber Risk - Global - September 2022

Risk[™] in action

Commercial real estate

ENERGY PRICES X COVID
DISRUPTION X ESG STANDARDS



Demand for office space in Europe is an example of long-term trends colliding with unpredictable shocks to shift a market and create financial pressures. On top of the ongoing disruption from the pandemic and broader shifts in working patterns, the commercial real estate sector is now further threatened by a generally weakening economic environment in Europe. Less square footage is expected to be available overall, as landlords either extensively renovate older buildings to comply with new environmental standards or redevelop offices to serve other uses altogether, like retail or residential.

The cost of renting office space will go up to compensate owners for new energy efficiency retrofits and companies looking to reduce their emissions can either upgrade to more energy-efficient space, reduce their total space, or both. This means that net debt to EBITDA⁸ ratios have weakened for many real estate investment trusts, increasing from an average of 11x in 2019 to 13x in 2021.

Source: ⁸MIS CMBS and REITs – Europe: Hybrid work will weaken demand for office space, with modest credit impact - July 2022



Investors and operators who can better anticipate developments in commercial real estate by piecing together previously separate data sets on occupancy rates, deal flow, and energy efficiency standards will be well-placed to capitalize — while those who are caught off guard risk losing out on financial value.

– Luis Amador

General Manager, Commercial Real Estate,
Moody's Analytics

PART 4

The Future of Risk^N

The trends that ushered in the Era of Exponential Risk are here to stay

Organizations aren't likely to unwind their vast — and growing — network of relationships or complex, multi-layered supply chains. Economies and countries will remain heavily intertwined. New risks will emerge, with the ability to influence other, longstanding risks.

Potential Exponential Risk “early warning” signs



Recent increase in the number of individual risks identified and mitigated



Ongoing market or industry expansion



Surge in online activity



M&A activity

Risk^N – Exponential Risk isn't a temporary state or moment in time: it represents a permanent shift in the nature of risk. Like the transition from agricultural to industrial and analog to digital, this is a fundamental revolution in how global systems work and interact.

This is the challenge facing companies and countries: The traditional approach to risk management — effective up to this point — is likely not sufficient to build resilience going forward.

For leaders and decision-makers, this creates new priorities:

In the c-suite

Tear down risk silos; seek expert data/analysis to learn more about priority risks when making decisions; drive interconnected risk planning.

At the board level

Incorporate assessments of the organization's risk domains and mitigation efforts, when evaluating decisions from a multi-stakeholder perspective.

In the public sector

Tailor policy and regulatory decisions to the new landscape, and design services and systems for resilience in the Era of Exponential Risk.

Looking ahead

The next frontier in the Era of Risk^N – Exponential Risk is the integration of massive and diverse data sets, made simple and visible by predictive analytics that help to anticipate the effects of emerging threats, identify vulnerabilities, spot and seize opportunities, and support lasting competitive advantage.

Building more agile and resilient organizations, economies, and communities — capable of anticipating and withstanding interconnected risk — is now essential to resilience. And while this new era presents a fresh set of challenges, leaders are already rising to the occasion. The expertise is there; the data and tools are there. We can meet the challenge of interconnected risk and thrive.

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