Global Insurance Market Opportunities

Re-Imagining Risk Management
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Introduction

The insurance industry continues to be flush with capital and in search of growth. Surveys and client experience are raising questions about the industry’s relevance in an era of rapid technological change that threatens to disrupt the traditional value chain. From our perspective, though, the hand-wringing is unnecessary. We think technology offers insurers tremendous opportunities for value creation.

In many industries, innovation is synonymous with start-ups that harness technology to create new products and services—and sometimes spark a transformation. Leading companies with scale and resources are generally assumed to be followers, not innovators.

Insurance is sometimes perceived as no different. We have seen the surveys and know from personal experience that questions are being raised about the relevance of large incumbents using technology to unlock value. However, the facts are that existing insurance companies are injecting capital into technology and innovation at a greater relative rate than other sectors. We should expect more experimentation and innovation in the future.

Riding the third wave of innovation

Steve Case, the founder of AOL, recently published a book, *The Third Wave: An Entrepreneur’s Vision of the Future*, which discusses the evolution of digital innovation. In the first wave (1985–1999), internet innovators such as Apple, Cisco, IBM, and Sun laid the foundation for the online world. The second wave (2000–2015), led by Amazon, Facebook, and Twitter, brought us the app economy and the mobile revolution. We are currently in the third wave, where technology will be integrated into “real world sectors”, such as transportation, insurance, healthcare, and food. In the third wave, the nature of the risk shifts away from technology and design, and towards barriers to product/service launch and regulatory constraints.

In prior waves, the incumbents were almost always positioned as victims—think Kodak and digital photography, Blockbuster being rendered obsolete by Netflix, or Sears losing ground to online retailers. In the third wave, incumbents must be the driving force in the industry’s digital strategy. If you believe that a dorm-inspired smartphone app will affect insurance in a meaningful way, you have a second wave mindset. And if your digital strategy is being led by first or second wave experts (from technology or analytics), you may be missing the newest opportunities.

So how can insurance companies adopt a third wave approach? The key will be partnerships; the “we do everything inside” attitude will not work for large companies, nor will it work for small start-ups. Similarly, leaving it to “the tech experts” or your existing analytics teams is a mistake.

It’s imperative for the C-suite at large incumbent insurers to be active participants in this wave of innovation. Executives can’t expect to outsource innovation to partners or simply swoop in to acquire promising start-ups. Instead, they must be able to take the lead in shaping the industry’s future.
In this year’s report, the 12th edition of our research findings, we examine ways in which companies—both incumbents and startups—are pursuing innovation across risk, capital, and data and analytics. Executives must recognize that new innovations can increase margin by taking costs out of the current system, as well as grow the industry by spurring demand for new capacity and opening new insurance markets. As this report discusses, exciting opportunities are being created by developments in disparate areas, from foodborne pathogens and autonomous vehicles to the on-demand economy, to name just a few. The common thread is the ability of analytics to reshape how insurers can seize these opportunities.

**About the Study**
This study has evolved from its beginnings as a quantification study for enterprise risk management. We now take an expansive view of issues related to global risk to encompass global growth, profitability, and market trends. We have organized the study around our key themes of risk, capital, and data and analytics. We strive to have this facilitate a broad discussion on matters of risk for participants across the value chain, from corporate CEOs and risk managers, to traditional insurers and reinsurers, to new participants looking to deploy their investment and capital into the industry.

Analytics remains at the core of everything we do. Highlights from our quantitative research can be found throughout the study. The study continues to provide the insurance industry’s leading set of risk parameters for modeling and benchmarking underwriting risk and global profitability. All parameters are produced using a consistent methodology that we have employed since the first edition. These parameters can be accessed through this study’s companion volume, *Global Risk, Profitability, and Growth Metrics*, at http://aon.io/gimo-companion-2017.

Beyond risk modeling, we can provide our clients with very granular, customized market intelligence to create business plans that are realistic, fact-based, and achievable. With a global fact base and broad access to local market practitioners, we are equipped to provide insight across a spectrum of lines, products, and geographies. Inpoint, the consulting division of Aon, helps insurers and reinsurers address these challenges, from sizing market opportunities to identifying distribution channel dynamics, assessing competitor behavior, and understanding what it takes to compete and win. Our approach leverages Aon’s USD 400 million annual investment in analytics, data, and modeling to help our clients grow profitably. All of our work at Aon is motivated by client questions.

We continue to be grateful to clients that have invited us to share in the task of helping them analyze their most complex business problems. Dynamic and interactive working groups always lead to innovative, and often unexpected, solutions. If you have questions or suggestions for items we could explore in future editions, please contact us through your local Aon broker or one of the contacts listed on the last page.
Section 1

The Insurance Market
Innovation in Insurance: The Emerging Open Architecture Model

Understanding the market

Three interconnected components are critical to the insurance market: demand from risk owners, supply from capital providers, and the data and analytics risk assessment capability needed to join the two and effect a transaction.

As in prior editions, we have dedicated sections of this study to the relevant trends in each of these three areas. In addition, we now see a fourth component of the insurance market exerting its influence on the other three: the transformative power of technology. But rather than view technology as a disruptor, we instead see it as a key source for renewal and growth.

Collaboration is key

Unlike earlier waves of the technology revolution, the “third wave” of innovation is taking place in industries with established incumbents that cannot be easily replaced by a new app on your phone. These industries—such as healthcare, transportation, education, and food, as well as insurance—tend to be capital-intensive, infrastructure-dependent, and are often subject to regulation and policy considerations that become critical factors to navigate in doing business. Despite the zeal and consternation over “disruptive” technology, the theme in third wave industries is more likely to be “technology + incumbents” than “technology vs. incumbents.”

Steve Case writes that third wave industries are characterized by having gatekeepers: the key decision makers that are responsible for approving products before they enter the market. While it is a relatively small task for an individual consumer to choose to ride an Uber or Lyft instead of a traditional taxi, it is a much larger task to change the technologies used in surgeries at major hospitals. And we accept having gatekeepers for surgeries—including doctors, regulators, and insurers—because a surgery comes with a level of risk that these gatekeepers help us to mitigate. For insurance, the incumbent system of carriers, agents, brokers,
and regulators are the gatekeepers that can allow emerging technologies to gain traction. So while we may fear would-be disruptors, it pays to remember: they need us as much as we need them. Hence the need for collaboration in the third wave.

What does this look like in practice? Collaboration in insurance can take many forms, from innovation labs to corporate venture capital funding for start-ups. We will discuss these in greater depth in the Capital section. And collaboration can either be experimental or core in nature.

- **Experimental** collaborations have the potential to really define the future performance of a company, but require a higher level of risk taking and acceptance of the possibility of failure. These collaborations tend to involve fewer participants as a result. For example, the blockchain consortium B3I was created to pioneer research on capital management and efficient transaction opportunities for its members.

- **Core** collaborations are inherently less risky, but can attract widespread participation from across the industry more easily. For example, Lloyd’s and London Market participants are investing in a new target operating model (TOM) that includes a placement platform aimed at reducing frictional costs.

In either case, participants work collectively to overcome potential hurdles such as standardization, regulation, and systems integration, at a reduced cost and with the assurance of mutual commitment.

**Opening up**

When we look at the possibilities for collaboration in insurance, it’s important to find a balance between the stability of gatekeepers and the creative potential of innovators. For this, we should seek to collaborate with an open architecture—in other words, a system that sets operating standards while at the same time allowing for a great deal of flexibility and permutation. When we think about the Apple App Store, the Google Play Store, or eBay, each of these platforms have become a commons where an astounding array of things are bought and sold by many buyers and many sellers, held together by a set of rules and norms that provide sufficient security for these markets to continue and thrive. Such an open architecture will be difficult to create in the current insurance environment – but we believe it is essential to us taking dynamic steps forward. Successful organizations will treat collaboration capability as a source of sustainable competitive advantage—and will invest in it accordingly.

**What steps should carriers take to ensure they stay with—or ahead of—the pack?** In either case, it will be hard to get there by going it alone.

**Insurers should strive to balance the types of collaborative initiatives they enter, and each come with different risks.** Through the TOM, for example, collaboration will improve the competitiveness of all London Market participants, helping to protect market share of participants from external threats in the process, but without tilting the playing field toward any one participant in particular. This form of collaboration needs to be chosen by all, for the benefit of all. But by itself, core collaboration is not enough. Experimental collaborations have the potential to provide a competitive advantage for those who choose to participate. These kind of collaborations have the potential to create new kinds of data and analytics, enabled by technology, to find new ways to bring insurance risk and capital together, and realize growth in this market.
The industry in 2016

Global insurance premium
**USD 5.1 trillion**

Global insurance capital
**USD 4.5 trillion**

Global property casualty combined ratio
**97.6%**

Property casualty premium
**2.0% of GDP across top 50 countries**

New capital and innovation

550+ InsurTech start-ups
challenging the traditional insurance industry model

Nearly
**USD 14 billion**
invested to date in InsurTech start-ups

More than
**55% of start-ups**
focused on improving customer interaction with insurance companies

More than
**USD 80 billion**
in alternative capital worldwide in 2016
Section 2

Risk
The complexity of cyber risk continues to advance and companies struggle to keep up, often despite best efforts to implement effective security programs. In this environment, enterprises who aim for cyber resilience reduce the risk of being impacted, and increase their ability to bounce back when they are hit.

It should surprise no one that cyber risk presents a host of challenges to businesses in today’s digital, connected world. The very technologies that are delivering new ways to innovate and add value also introduce new risks, and increased connectivity with customers means companies’ exposure points are increasing exponentially. Threats evolve rapidly and can quickly endanger companies that do not keep pace. Organizations are under pressure to refine their defenses against attackers who are constantly advancing their techniques. And regulators are also trying to keep pace, further complicating an organization’s risk management environment.

Cybersecurity has traditionally been thought of as a technology issue: devices are vulnerable. Spend more on security, and you’ll be better protected. But the majority of companies spend less than 12 percent of their IT budget on cybersecurity and more than 15 percent spend almost nothing on security. It’s not just IT budget constraints that mean that cyber should no longer be treated as a pure technology problem. Even if IT departments had unlimited budgets to spend on cybersecurity, the evolving nature of the threats facing them means they will always have residual risk that they need to transfer off the balance sheet. What is more, a cyber attack impacts every area of the business, including finance, operations, customers, human resources, brand, regulatory compliance and more. It therefore requires a holistic, multi-disciplinary approach to manage it.

Thus we live in a world where approaching cybersecurity as a technology problem, or with a fragmented approach, is insufficient; cyber is a far-reaching, enterprise-level risk. The concern is no longer just about technology, but also about people, processes, and economic motivations. Companies need to consider their exposure, threats, and vulnerabilities, and go further to quantify probabilities and financial impacts. This means they need to be looking across the whole spectrum of options that can help reduce their risk, and make sure they bounce back if they fall victim to an attack—from technology and tools, to information security processes and programs, to the transfer of risk through insurance products.

To date, however, conversations about cybersecurity and cyber risk transfer have often occurred in separate parts of the organization: the former with the CIO or CISO and the latter with the risk management or finance function. Furthermore, a lack of coordination between these functions can often lead to counterproductive outcomes. To the CISO, buying cyber insurance could imply the network is not secure, and he or she is not doing the job. To the risk manager, cyber risk is a technology problem. Regrettably, there may be no one in the organization who sees cyber risk for the enterprise issue that it is.

Fortunately, the boards of directors in many corporations are starting to take a more aggressive role in addressing cyber risk. The potential for boards to be held legally accountable should a breach or other cyber-related incident occur is compelling them to act. Whether executives will heed the board’s direction is another question entirely.

Companies should strive for a coordinated and comprehensive assessment of cyber risk—which will put them on a path toward cyber resilience. Every organization has information security issues, despite best efforts to avoid them. Resilient organizations are prepared and can bounce back.

Cybersecurity and cyber risk practitioners feel the need for a dialogue that uses a common lexicon that allows for true understanding of the risks, how they manifest themselves, and how to detect, respond, and recover from an incident. That lexicon is starting to take shape as organizations come to terms with the likelihood, vulnerabilities, and impacts that cyber threats present. A common lexicon allows risk management to be operationalized across the enterprise, with clear language that is free of jargon and ambiguity and can address root causes. And the metrics and measurements essential to risk management should be quantified, wherever possible, and cited in terms that are compatible with the insurance sector so that insurers can get more comfortable with the risks and offer companies more robust protection policies. Aon has taken the lead in integrating the deep cybersecurity expertise of Stroz Friedberg with experienced professionals in risk transfer.
The cyber resilience framework shown on the right offers a comprehensive approach to managing cyber risk, beginning with accurate risk assessment on the front end to effective incident response on the back end. The framework includes the traditional insurance areas of expertise—quantifying and transferring risk—but now supported by pre- and post-breach services to identify and mitigate risk, and to quickly recover should such an incident occur.

The handling of cyber risk has moved beyond traditional insurance. The typical cyber insurance policy will offer access to a panel of service providers for incident response and, perhaps, additional services. These services—whether offered by a carrier directly or through partnerships—give insurers a way to broaden their value proposition beyond a simple insurance policy. Feedback from insureds, as they better understand their exposure, is helping to make policies more tailored and useful.

Insureds can reduce the impact of cyber incidents through a range of measures that help them protect, detect, and recover effectively. According to Ponemon’s Cost of Cyber Crime report, proactive steps—such as incident response, training and awareness, and use of encryption—can cut the cost of a breach by more than 10 percent.

The time to detection and time to response also affect the damage that a bad actor is able to inflict on a company, and therefore the financial impact. Companies that reduce the time to identify a breach and subsequently contain it, suffer lower costs associated with the breach. While time to detect an incident is decreasing across industries, the average time is still high—at 191 days, according to Ponemon.

Implementing a more proactive cybersecurity program can help reduce this “dwell time.” Adhering to best practices, such as backing up data, conducting regular patching, and participating in intelligence sharing will not only reduce a firm’s exposure, but also limit the damage should such an incident occur. Having measures in place in advance can also provide additional assurance to insurance providers of the company’s readiness to manage risk, and help secure them better coverage.

The framework above illustrates a new approach to cyber resilience: not cybersecurity or cyber insurance, but both working together to protect the enterprise. Effective use of cyber insurance policies and cybersecurity programs means a company can reduce the risk of being impacted in the first place, decrease the time to restore normal business operations, and protect itself from the financial impact of catastrophic cyber events.

### Applying the framework

A client sought to quantify its exposure and coverage requirements. It faced competing stakeholder interests, but needed to assess its exposure to cyber-related risk and establish objective and appropriate coverage limits. While the company’s risk manager initially found that USD 100 million in limits would suffice, Aon’s cyber impact analysis concluded that an estimated maximum loss could exceed USD 400 million. As a result of the analysis, the board of directors approved a premium budget commensurate with USD 500 million policy limits.
Global Insurance Market Opportunities

The threat of foodborne illness and catastrophic animal disease create opportunities for insurers that can harness data and analytics.

The insurance and reinsurance industries have regularly explored the implications of a human epidemic as an emerging risk. The focus has primarily been on the life insurance sector’s ability to absorb a large mortality shock similar in scale to the 1918 “Spanish” influenza pandemic, which was estimated to have killed more than 50 million people globally. More recently, the outbreaks of Ebola in West Africa and MERS-CoV in the Middle East and South Korea have sparked renewed conversation about the risk pathogens pose to the broader economy. This dialogue led to the exploration of new products, such as non-damage business interruption, where a company may suffer an economic loss from disruption of operations by a peril that is excluded by traditional property coverage, such as disease.

While much effort has been expended on attempting to quantify human epidemic morbidity and mortality events in the market, other sectors, particularly food and agribusiness, are increasingly at risk of disruption from pathogens. Increasing availability of novel data sources and open source analytical platforms has greatly expanded the ability to quantify risks more accurately throughout the supply chain. However, deep industry and technical expertise are still required to use insights from data and advanced analytical capabilities to guide product development in the most effective manner.

Changing landscape in food safety
The World Health Organization (WHO) estimates that 600 million people in the world, or one in ten, become sick from foodborne illness each year. Of these, 420,000 die from their illness. In the United States alone, the Centers for Disease Control and Prevention (CDC) estimates around 48 million people get sick from foodborne illness per year, with a total cost to the economy of USD 77.7 billion.

The risk landscape for food and agribusiness is changing. With increased globalization and complexity of food production and distribution supply chains, foodborne illness outbreaks are no longer limited to local point-source contamination events within a geographic range. Now, outbreaks can span the globe and cause illnesses linked to the same food in many different regions simultaneously, potentially leading to unrecognized and uninsured exposures associated with these extended supply chains.

To address the potential for widely disseminated foodborne outbreaks, the CDC and regulatory agencies in 1996 developed a surveillance network called PulseNet that uses pulsed-field gel electrophoresis (PFGE) technology to produce a genetic “fingerprint” of foodborne bacterial pathogens. This fingerprint can be used to link illnesses across wide geographies and also to specific food items. Even though PulseNet radically improved the ability to detect outbreaks and trace the source of illnesses, PFGE is not a silver bullet. In fact, CDC has described the comparison of isolates using PFGE fingerprints as analogous to comparing two books based on the number of words in each chapter—not particularly high specificity in some cases. Even when PFGE data are coupled with epidemiologic and traceback results, foodborne illness attribution is a difficult task. In 2015 alone, 902 foodborne disease outbreaks were reported to CDC, which led to only 20 recall events. Therefore, even though PFGE has been a game changer for food safety in the industry, the actual likelihood of illnesses sparking a significant number of product recalls has historically remained fairly low. That being said, those outbreaks caused 15,202 illnesses, 950 hospitalizations, and 15 deaths, any of which can lead to significant liability concerns for a food company linked to an outbreak.

In 2015 alone, 902 foodborne disease outbreaks were reported to CDC, which led to only 20 recall events.
However, in recent years the product contamination and recall risk profile for food companies has changed dramatically with the implementation of whole genome sequencing (WGS) and the integration of robust historical pathogen data sets. Unlike PFGE, WGS compares the full genetic sequence of pathogen isolates to determine their similarity. To continue CDC’s book analogy, comparing pathogen isolates using WGS would be the equivalent of comparing every word in each chapter to determine if the two books are the same, resulting in much greater specificity. WGS data can also provide information about other important risk factors, such as the presence of particular virulence genes and whether the pathogen may be resistant to certain antibiotics.

Therefore, WGS data can oftentimes do a better job of matching illnesses among different consumers, leading to detection of smaller outbreaks that may have gone unrecognized by PFGE. Coupled with epidemiological data, it can also give public health and regulatory agencies an increased capacity to attribute illnesses to particular contaminated food products. This finding is complemented by increasing regulatory scrutiny under new US Department of Agriculture (USDA) food safety performance standards and FDA’s Food Safety Modernization Act. Together, these oversight capabilities place food companies in a position where data and analytics must be used to greater effectiveness to better quantify and mitigate their risk of contamination and potential liability associated with broader supply chain risks.

Increasing food risk complexity

The application of technologies such as PFGE and WGS, as well as increases in overall data availability, will continue to improve the safety of the food supply chain, but they will also lead to greater complexity in understanding a food company’s liability risks. The design of the US foodborne disease surveillance system allows for comparison of molecular test results from ongoing in-plant, retail, and patient sampling to a database of historical test results. This comparison often identifies other consumer illnesses linked to the outbreak that were previously unrecognized, which can lead to increased time under investigation and ongoing, expanding recalls for an implicated company. That being said, WGS can also serve as a protective measure, where a food item manufactured by a company may be suspected of causing a foodborne illness outbreak, but through WGS it is shown that samples taken from the suspected company and its products are not actually related to the outbreak strain.

Such increasing complexity will require the insurance industry to develop new and innovative analytical techniques to properly understand and quantify risks in the food supply chain and adequately cover food company exposures. A one-size-fits-all approach to product contamination and liability coverage will not be adequate, even for small to midsize companies in this evolving risk landscape.

“Routine application of whole genome sequencing will lead to a considerable increase in the number of foodborne disease outbreaks detected and traced back to source. Based on experience with the foodborne pathogen Listeria monocytogenes, these tools may detect between 2 to 3 and 100 times more foodborne disease outbreaks than identified without these advanced tools. Outbreaks detected will typically involve fewer patients though, which reflects both detection of smaller outbreaks and earlier detection of outbreaks that are hence contained before a larger number of patients are affected.”

Dr. Martin Wiedmann, DVM, PhD
Gellert Family Professor in Food Safety
Cornell University
“Today, US citizens reap the benefits of a robust agricultural industry that provides them with access to a safe, abundant, and affordable food supply that is readily available on the shelves of grocery stores nationwide. This is a privilege that, as you well know, does not exist globally. The very elements that make the US agricultural system robust and productive also make it vulnerable to a natural or intentional introduction of a biological agent. In order to be better prepared, we must address our vulnerabilities through leveraging new technologies and risk management products.”

Dr. Tammy Beckham, DVM, PhD
Dean of the College of Veterinary Medicine
Kansas State University

**Catastrophic animal disease**

The United States has not seen foot-and-mouth disease in the country since 1929. Until 2014, avian influenza had only been detected in the United States in 1924, 1983, and 2004. The European Union has recently responded to multiple AI outbreaks as well as encroachment by African swine fever. These foreign animal diseases are all highly contagious and move rapidly across international borders. In countries that have significant industrialized animal agriculture, they can have a catastrophic impact on the domestic economy and international trade.

In nonendemic countries, the response to an outbreak is swift and devastating—usually resulting in regional quarantines, mass depopulation of animals, and increased surveillance by regulatory authorities. In most cases, international trading partners will close their borders to products derived from the affected species, which can cause shocks to market prices and have a huge impact on other industries that are reliant on the animal production sector. This ceasing can also cause serious business interruption risk for independent growers, farmers, or both, as well as larger risks of supply chains for processors and their customers. For instance, the 2014–15 highly pathogenic avian influenza outbreak in the United States caused significant disruption to the turkey and egg industries as well as to those sectors that rely on their products—in all, the outbreak is estimated to have cost the US economy USD 3.3 billion. An even more worrisome situation is the potential introduction of foot-and-mouth disease into the United States, which could simultaneously affect beef, dairy, pork, and lamb production and potentially cost upward of USD 188 billion according to recent models. The supply chain implications for such a disruption are great, considering many sectors outside the meat and poultry industries rely on animal-derived products as primary inputs for their own production.
The market consists of a few insurance products that provide a safety net to the US meat and poultry industries to address the risk of a catastrophic animal disease event. Most livestock mortality coverage specifically excludes regulated diseases (for example, foreign animal diseases) and existing USDA Risk Management Agency livestock programs such as the Livestock Gross Margin and Livestock Risk Protection would require major Congressional statutory changes to make them viable. Currently, animal producers have very few risk management options for the potential price shocks associated with disruption to domestic and international markets caused by a foreign animal disease introduction.

Recent outbreaks in Europe and the United States have stressed the need for pathogen loss mitigation tools for the meat and poultry industries. Increasing availability of data and access to industry-specific pathogen and economic models show new potential for the application of these tools. Insurers looking for growth in the food and agribusiness industries must have industry access and specialized risk expertise to explore the development of nontraditional product offerings.

**The potential impact of open data and analytics**

The global move towards open source software and publicly available data provides an incredible opportunity to address risks in currently underinsured or uninsured areas. Similarly, the increasing capacity in WGS and bioinformatics has opened new opportunities for novel application of biological data to the insurance and reinsurance sectors.

In the food space, the GenomeTrakr project is a distributed network of laboratories that use WGS for the identification and tracking of foodborne outbreaks. The publicly available WGS data and metadata include more than 113,000 isolates uploaded to the database, which is growing at more than 3,500 isolates per month. In a similar fashion, influenza sequences are uploaded to publicly available databases at the National Institutes of Health, which include more than 550,000 records of avian influenza animal surveillance samples spanning multiple decades and covering most regions in the world.

Beyond publicly available data, open source programming languages (like R and Python) have democratized analytics, allowing anyone to learn coding skills and analytical techniques using free software and online training courses. This impact is especially evident in projects such as Bioconductor and websites similar to Nextstrain, which provide anyone the capability to manage, analyze, and visualize genomic data in real time as sequences are uploaded to publicly available data sets.

Even with emerging access to these powerful tools, significant barriers still remain for companies looking to successfully monetize data and analytical capabilities. They must be willing to invest in highly skilled industry and analytical experts who can integrate market knowledge and advance these capabilities for product development and deployment.

The potential introduction of foot-and-mouth disease into the United States could cost upward of USD 188 billion according to recent models.
What's Ahead For Commercial Auto Insurance?

Smaller companies have mostly outperformed larger ones. However, the disproportionate size of the larger segment is dragging down the line’s overall results. What is driving the current dynamics and what is the impact of new technologies for the line?

Commercial auto liability has been challenging for the insurance industry over the last five years, with cumulative direct underwriting losses of USD 10.2 billion and cumulative net underwriting losses of USD 8.4 billion.

No single reason explains the line’s poor results; rather, participants have noted the following contributing factors:

- Unexpected increases in:
  - exposure (miles driven)
  - claims frequency
  - claim severity
- Rating misclassifications
- Drivers unqualified for the vehicle they operate
- Distracted driving
- Delays in claim reporting
- “Nuclear” verdicts

The industry has been pursuing rate increases in commercial auto since 2011 in response to its deteriorating results according to the Council of Insurance Agents and Brokers. In terms of the market cycle most commercial casualty lines started seeing rate decreases in late 2014 and early 2015. Although rate increases slowed down for commercial auto during this period, the rate changes remained positive. This timeframe marks a divergence between commercial auto rates and the other commercial lines. Having separated from the rest of the pack (and package), commercial auto is expected to continue to see positive rates for the foreseeable future.
Drivers of loss
Companies writing commercial auto insurance have noted various causes for unexpected losses, as mentioned above. There was a noticeable “shock” in loss trends between 2009 and 2010. The years preceding 2010 saw a favorable loss trend; however, the trend reversed in 2010 and 2011. Loss trends observed for 2012 through 2016 appear to be modest. Furthermore, changes in productivity tend to associate with sharp changes in loss trend for the line.

Changes in loss trend and productivity

In the graph, changes in productivity (measured here by output per employee for truck transportation classes) track changes in loss trend. Recognizing that loss trend is ultimately a function of various underlying factors, this illustrates that shocks in productivity more or less correspond to shocks in commercial auto loss trends. We believe that this makes intuitive sense as most models simply rate on units, with little ability to differentiate rates based on the actual “work” done per unit. Changes in productivity essentially create changes in the underlying exposure, which may not prompt a change in insurance rate.

Furthermore, academic literature demonstrates that companies that just meet earnings (suspect firms) have higher on-the-job injury rates than companies that comfortably beat or miss earnings. This illustrates another possible concern with increases in productivity: does productivity increase because of “cutting corners” or other behaviors that have an adverse insurance implication?

There are also societal trends that likely have an impact on automobile insurance. For example, a much larger percentage of drivers are over the age of 60 compared with 15 years ago. Also, in many states, there has been an increase in maximum speed limits in the last four or five years. Although these trends are observable on a large scale, it is hard to quantify their impact for any single auto liability exposure.

Commercial auto within package policies
Commercial auto liability has historically been overshadowed by general liability and workers’ compensation within commercial package policies. However, industry results and significant adverse developments since 2011 have put the spotlight on the line and highlighted the need for corrective action.

Excluding companies that write only auto physical damage, the average combined commercial auto liability and physical damage premium for all carriers over the last five years was USD 27.9 billion. Most of the commercial auto premium (85 percent) is earned by carriers that have significant footprints in other commercial lines (over 50 percent), or “package writers.”

### Commercial auto: by specialists and package writers (USD billions)

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<th>Percentage of company counts</th>
<th>Share with net underwriting gain</th>
<th>Five year average commercial auto premium volume</th>
<th>Percentage of total commercial auto premium volume</th>
<th>Five year average net underwriting result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Commercial auto</td>
</tr>
<tr>
<td>Specialists</td>
<td>95</td>
<td>27%</td>
<td>57%</td>
<td>4.2</td>
<td>15%</td>
<td>0.1</td>
</tr>
<tr>
<td>Package Writers</td>
<td>252</td>
<td>73%</td>
<td>47%</td>
<td>23.7</td>
<td>85%</td>
<td>-2.1</td>
</tr>
<tr>
<td>Total</td>
<td>347</td>
<td>100%</td>
<td>50%</td>
<td>27.9</td>
<td>100%</td>
<td>-2.0</td>
</tr>
</tbody>
</table>
It may be surprising to see that 50 percent of the company groups have had an average five-year net underwriting gain in commercial auto; however, these companies are disproportionately small:

**Commercial auto: by size of company (USD billions)**

<table>
<thead>
<tr>
<th></th>
<th>Company counts</th>
<th>Percentage of company counts</th>
<th>Share with net underwriting gain</th>
<th>Five year average commercial auto premium volume</th>
<th>Percentage of total commercial auto premium volume</th>
<th>Five year average net underwriting result</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEP &gt; USD 50 million</td>
<td>82</td>
<td>24%</td>
<td>16%</td>
<td>25.6</td>
<td>92%</td>
<td>-2.0</td>
</tr>
<tr>
<td>NEP &lt; USD 50 million</td>
<td>265</td>
<td>76%</td>
<td>60%</td>
<td>2.3</td>
<td>8%</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>347</td>
<td>100%</td>
<td>50%</td>
<td>27.9</td>
<td>100%</td>
<td>-2.0</td>
</tr>
</tbody>
</table>

In general, smaller companies have outperformed larger ones in commercial auto. Furthermore, larger companies writing commercial auto as part of a package policy have had a disproportionate impact on the overall commercial auto result:

**Commercial auto: package writers with NEP > USD50 million (USD billions)**

<table>
<thead>
<tr>
<th></th>
<th>Company counts</th>
<th>Percentage of company counts</th>
<th>Share with net underwriting gain</th>
<th>Five year average commercial auto premium volume</th>
<th>Percentage of total commercial auto premium volume</th>
<th>Five year average net underwriting result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ccakage writers and NEP &gt; USD 50 million</td>
<td>69</td>
<td>20%</td>
<td>12%</td>
<td>22.1</td>
<td>79%</td>
<td>-2.1</td>
</tr>
</tbody>
</table>

Such carriers make up 79 percent of the market by premium volume, yet represent only 20 percent of the carriers; however only 12 percent of this subset of companies had an average five-year net underwriting gain.

There are several possible explanations for the performance differences between smaller and larger carriers:

- Smaller companies may be more likely to have specialization as regards target classes, regions, and agents; larger companies may err on the side of broader product offerings for more heterogeneous risks.

- Larger companies tend to have commercial auto presences in multiple segments (for example, specialty, middle market, and main street). Often, segment oversight is explicit but commercial auto product oversight may not be uniform by segment. Consequently, as problems arise in the line, a lack of a single source of ownership for the product may delay a coordinated company response. This tends to be less of an issue for smaller companies.

- Numerous companies write small amounts of commercial auto (under USD 2 million a year). In these cases, the insurer may more or less understand the risk and include the commercial auto when the exposure is incidental. This is conceptually akin to exposures at minimum premiums. Across all small carriers, the exposure produces an above-average return. To the extent companies continue to generate profit on the entire commercial lines package, the incentive to make isolated corrections to commercial auto may be dampened, allowing the underwriting results between package writers and specialists to further diverge.
Looking forward, diminishing reserve redundancies in commercial lines threaten the profitability of the package; consequently, attitudes regarding commercial auto are likely to change. In the short term, smaller companies can be nimble in responding to challenges whereas larger companies are often unable to respond as quickly. In the long term, larger companies have the data, scale and resources to bridge the gap or even outperform their smaller peers. However, this will require overcoming inertia and institutional and structural obstacles. Implementing strategic partnerships in the technology and data space could potentially shorten the time horizon for larger companies that are more motivated to leverage their advantages.

How do these observations compare for personal auto?

<table>
<thead>
<tr>
<th>Company groups (%)</th>
<th>Share with net underwriting gain</th>
<th>Five year average auto premium volume</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Commercial</td>
<td>Personal</td>
</tr>
<tr>
<td>NEP &gt; USD 50 million</td>
<td>24%</td>
<td>20%</td>
</tr>
<tr>
<td>NEP &lt; USD 50 million</td>
<td>76%</td>
<td>80%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Structurally, personal auto is similar to commercial auto in terms of both the frequency and market share (by premium) of large companies. A key difference between these two markets is the profile of auto in the package.

In the commercial space, 85 percent of all commercial auto premium is considered ancillary (earned by package writers where auto is less than 50 percent of their commercial lines).

In contrast, for personal lines only 4 percent of all personal auto premium is considered ancillary (earned by package writers where auto is less than 50 percent of their personal lines). This is intuitive as there are fewer personal lines of business relative to commercial lines of business.

The sharp contrast in this metric between personal and commercial suggests that any profitability issues with the auto would likely be addressed more quickly in personal than for commercial from a relative importance perspective.

The road ahead

Advances in technology and safety will improve underlying exposures. The Insurance Institute for Highway Safety tests new technology in cars to assess safety benefits. Fleet optimization telematics tend to focus on operational efficiencies and enable commercial auto risks to squeeze more efficiency (productivity) out of their fleets. We believe there is an insurance impact from both these trends. As telematics technology penetrates more fleets, it could potentially allow commercial auto insurers access to new sorts of data that could provide significant insights. In addition, we believe that the expanding footprint of telematics technology will disrupt the rating of commercial auto insurance. The insurance product may evolve from strict unit rating to a driver score or real-time driving rating that could be a function of behavior, route densities, and other granular data generated by telematics providers.

Market forces are further transforming commercial auto exposures, and there are numerous examples in the on-demand, or sharing, economy, such as ride-sharing, which blends personal auto use with part-time commercial livery. In the trucking sector, 53-foot trailers are increasingly competing with smaller trucks and vans for local delivery. Another development is how the electronic logging device mandate, scheduled to take effect later this year, may transform the trucking industry. If complying with this mandate is costly or otherwise problematic for smaller independent trucking companies, how will that reshape the transportation landscape?

All the trends suggest commercial auto insurance is undergoing a transformation.
Insurance and Autonomous Vehicle Risk

Who will be responsible for accidents in the emerging world of autonomous vehicles and who will pay for them? Big changes are coming, and the industry must start preparing now.

Transportation as we know it is being challenged from many perspectives. Safety is the primary driver behind the technology arms race that has channeled billions of dollars into R&D, beginning with the introduction of advanced driver assist systems (ADAS) features into mostly luxury vehicles today. Original equipment manufacturers and their suppliers are working to make collision avoidance systems such as emergency brake alert and assist, lane departure warning, and blind-spot detection affordable for mainstream vehicles. In 2016, 20 automakers signed an agreement with the National Highway Traffic Safety Administration to make emergency brake assist a standard feature in US vehicles by 2022.

In addition to features built into vehicles, "Mobility Services" are and will continue to attack the financial inefficiencies of the current car ownership model. These services include Uber and Lyft, as well as more recent ventures from OEMs such as GM’s Maven or BMW’s ReachNow. This aligns with the demographic and urbanization trends that are calling into question traditional car ownership in large cities. The average family-owned car sits idle for up to 21 hours a day. Purchasing transportation “by the mile” from a mobility service could not only be more cost effective, but also more convenient and flexible when considering the wide variety of vehicles available to consumers.

In this new world, who is going to be responsible for accidents? And how will insurance work? What role and responsibilities will be required of infrastructure to make this all work?

Reviewing the legacy model

As we explore where liability for accidents may end up in this rapidly changing environment, it is important to review how it has worked for the past 75 to 100 years. The sobering fact is that we experience over three million accidents a year on US roads. This resulted in an estimated 40,000 deaths in 2016—a 6 percent increase compared with 2015 and a 14 percent increase over 2014—the most dramatic two-year rise in 53 years, according to the National Safety Council. Just as alarming is the industry estimate that about 94 percent of all accidents are the result of poor human decision making.

With the driver being the responsible party in the large majority of accidents, our insurance and regulatory systems have naturally focused on insurance for the owners of vehicles and their assigned drivers. State-by-state regulations place responsibility on vehicle owners to purchase minimum amounts of insurance coverage and track each licensed driver’s performance through point systems associated with violations.

Insurance companies use this information, along with a variety of demographic information, to create rating models. These models determine the probability of an applicant causing a traffic accident during the upcoming policy period. In most states, injured parties and their attorneys look to the at-fault vehicle owner and their insurance company for remedy. The overall model works, with the insurance companies paying the majority of claims funded by the premiums and the deductibles of the individual vehicle owners. In a small percentage of cases, the insurance company that paid the claim can subrogate against another responsible party such as the vehicle manufacturer or infrastructure provider that may have contributed to the cause of the accident.

94 percent of all accidents are the result of poor human decision making.
Risk, responsibility, and insurance in the future

A major premise behind autonomous vehicles is the hope that they will prevent the 94 percent of current accidents involving human error. This would have a substantial disruptive impact on the current regulatory, legal, and insurance industry approach. For example, automobile insurance has become the largest segment of the overall insurance industry, amounting to 47 percent of global insurance premiums. In last year’s report, we stated that if autonomous vehicle technology is adopted at even a moderate pace, US motor pure premiums could decrease by 20 percent by the year 2035 compared with their 2015 levels—and by more than 40 percent by 2050 when autonomous vehicles are expected to reach full adoption.

Who will be responsible for the remaining claims and who will pay for them? If human decision making is completely replaced by machine, then consumer (autonomous vehicle owners and passengers) expectations will likely be, “It can’t be me, I’m not driving anymore!” It is currently expected that the focus will shift primarily to the vehicle manufacturers and their software and component parts suppliers, the companies developing the technology that will take on the ominous task of anticipating all driving situations that were formally the responsibility of humans.

Where does infrastructure fit in?

Infrastructure will play a key role in bringing this all together to a workable solution. As it exists today, infrastructure providers, such as state and local governments, will be required to provide safe roads to accommodate moving traffic. However, signage and lane markings will need to be repurposed for direct communication with vehicle sensors and cameras, rather than only available for human viewing. Similar to current day, if these signs and markings are designed and installed improperly, infrastructure builders and operators may be held liable. A significant challenge that has already been identified is the inconsistency of physical materials (paint, reflectors and metal) used across state and local roads combined with the varying sensor technology used by each vehicle OEM.

In addition to the preparation of the physical roads, one of the most significant risks facing infrastructure providers will be the digital communication to vehicles at an intersection. Today, four vehicles approaching an intersection rely on the human driver to interpret the signaling (static signs or variable traffic lights) to make decisions on vehicle priority. In the future, vehicles in communication with each other combined with digital signaling from local infrastructure will be used to manage intersection safety and traffic flow. This more complex responsibility could lead to incremental liability at all levels of government and their subcontractors.

So, while manufacturers and infrastructure providers will also benefit from the lower frequency of accidents, they are likely to experience increases in regulatory requirements related to liability and insurance as well as a higher cost-per-claim related to more severe accidents. One contributing factor will be the vast amounts of pre and post collision data captured by each vehicle. Today’s human-caused accidents rarely provide certainty around what factors contributed to a collision. Not only will data collected by vehicles of the future provide precise information on accident situations, reducing uncertainty in the insurance underwriting process, but it will also lead to a less complex claim resolution process between the involved parties.

Parking will also become a disrupted by-product in the autonomous vehicle world. Mobility services that will keep vehicles in virtually continuous use throughout the day will make current parking infrastructure largely redundant. Those vehicles needing to be parked will have the capability of self-parking at less-costly remote locations, thus eliminating the need for convenient parking in close proximity to the passenger’s destination. Future parking spots will also be expected to come equipped with electric charging stations (the likely fuel of the future) capable of recharging a vehicle without human interaction.

While it is clear insurance will continue to have a role in this evolving space, it is incumbent on the industry to work together with autonomous vehicle providers and governments to explore emerging risk management needs. The second- and third-order implications of increasing adoption of autonomous vehicles will create challenges as well as new opportunities for the industry.
Rise of the On-Demand Economy

The insurance industry has been slow to embrace this fast-growing business model, but new players are introducing innovative concepts. Incumbents must stay on top of developments and look for ways to incorporate them.

Over the past five years, the world has witnessed the rise of the on-demand economy (ODE)—where people use internet and mobile technologies to access and exchange goods, money, services, resources, and information on a peer-to-peer level, rather than through a traditional corporate vendor. Popularized by the likes of Airbnb and Uber, it has emerged as a worldwide movement that is shaping the global economy and is influencing industries such as transportation, travel, and retail.

The insurance industry has a role to play in the development of the ODE, including security and risk mitigation standards across platforms. But that’s only a start. Digital technology is putting pressure on the industry’s traditional economic models. Incumbents must take heed.

Changing currents
Revenue from the ODE is growing—PwC estimates that revenue from the ODE could reach USD 335 billion worldwide by 2025. While the scale is global, pockets of development are currently regional, and the scope for further geographic expansion remains substantial. The ODE’s influence on job creation is also significant. According to a poll from TIME, 22 percent of American adults, or 45 million people, are using or have used the platforms to offer some kind of good or service—a massive contingent of independent workers. The ODE will create opportunities across the globe. But, like all major disruptors, it is putting pressure on existing business models, regulatory frameworks, and spurring other significant changes.

The ODE is characterized by economic and social activity where people and businesses use internet and mobile technology to gain instant, pervasive access to goods, services, experiences, resources, information, and money without the burden of ownership or long-term commitment. It is variously called the sharing economy, the peer-to-peer economy, the gig economy, and the platform economy. No matter what you name it, on-demand platforms and services are changing the way people work and interact with businesses of any size.

A number of technological and demographic shifts have paved the way for the relevance of the ODE:

- **Technological innovation**—ubiquitous internet service, enabled by mobile phones and social networks together with new payment approaches, are changing consumer expectations for convenience of services.
- **Values**—preferences are shifting toward experience or access rather than ownership, buoyed by customer desires for community and active citizenship. These trends promote the ODE through a desire for authentic experiences.
- **Economic realities**—the current financial climate, together with debt loads borne by many millennials, encourages cost savings by consumers and spurs ODE suppliers to earn extra income where possible.
- **Social and environmental**—increasing population density and urbanization, combined with longer life expectancy and sustainability initiatives, are raising the awareness and desire for quality goods and services. Millennials, who make up half the US working population, underpin these trends.

An element common to all ODE businesses is the presence of a platform that brings together providers (supply) and users (demand) of on-demand goods and services.

The insurance industry can play an important role by promoting standards for security and risk mitigation across on-demand economy platforms.
By the numbers
Statistics from the 2015 National Technology Readiness Survey reveal a picture of the on-demand economy in the United States.

The US on-demand economy in 2015: USD 57.6 billion

<table>
<thead>
<tr>
<th>Category</th>
<th>Revenue (USD billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online marketplaces</td>
<td>35.5</td>
</tr>
<tr>
<td>Transportation</td>
<td>5.6</td>
</tr>
<tr>
<td>Food and grocery delivery</td>
<td>4.6</td>
</tr>
<tr>
<td>Other services</td>
<td>8.1</td>
</tr>
<tr>
<td>All other categories</td>
<td>3.8</td>
</tr>
</tbody>
</table>

As shown in the chart, online marketplaces, such as eBay, generate more revenue than all other sectors combined.

According to Harvard Business Review, while ODE services are typically associated with millennials (ages 18-34), in fact a majority (51 percent) of users are from earlier generations, with 29 percent aged 35 to 54, and 22 percent aged 55 and older. Furthermore, the TIME poll revealed that 71 percent of people report having a positive experience working in the ODE industry. Industry projections estimate that independent workers will form 40 percent of the total US workforce by 2020.

The role of insurance in the ODE
Despite the success thus far, and the seemingly endless array of phone app-based mechanisms to deliver new services, the on-demand economy must address several challenges to realize its potential. These include issues of trust, including consumer safety, consistency in service quality, and data privacy. The insurance industry can play an important role by promoting standards for security and risk mitigation across ODE platforms. And insurance itself can help address these challenges. We have already seen insurers work with ride-sharing companies to provide excess and umbrella liability policies. This is only the beginning. But to address the larger issues with ODE, insurers need to grapple with their own challenges.

Insurers face underwriting and pricing hurdles to adapt to the ODE world. ODE transactions are temporal, episodic, and small—quite different from traditional insurance. Many of the new ODE insurance products are small and specific, with coverage orchestrated alongside more traditional insurance products—as an example, “gap” policies for ride-sharing drivers. Insurers are struggling to determine a way to dynamically assess and price micro-transactions, and accumulate enough of them within their portfolios to make them profitable. This also requires integration of the coverage into mobile apps or platforms to identify when coverage is “on,” and thus to determine the corresponding premium.

Analytics and technology will play important roles in addressing the outstanding issues with ODE insurance. Enhanced user information is helping market players to better understand the risks in the sharing economy. Improved data collection through technology will help insurers better understand customer behavior, using sources such as mobile devices, connected homes, and wearables. Over time, technology will lead to a more precise understanding of the risk and correct underwriting of premiums.

The ODE is also changing customer expectations for the insurance industry. The fast growth of mobile services and social media has accelerated changes to risk management, and created ways for insurance to engage with people. This is a good thing for an industry that has long suffered from negative customer perceptions.

In addition, newcomers are moving into the insurance industry in the form of managing general agents, agents, and carriers. An increasing number of digital aggregators are hosting products from a variety of insurance providers. These new arrivals offer strong customer engagement, innovative technology, and large volumes of valuable consumer data. Incumbents must rethink their strategies and find partners that can provide relevant skills, prominent brands, advanced technology, and strong presence in desired markets.

The on-demand economy is an exciting example of where the second wave and the third wave of innovation meet. ODE business and customer expectations are challenging the insurance industry to become more nimble in its assessment of risk, and the insurance industry can use its incumbent expertise to shore up the weaknesses in current ODE business models. Where this potential symbiosis could lead, we will have to wait and see.
Global economic weather loss trend

Property catastrophe losses continue to dominate the headlines, driving the largest individual losses in every region.

For the fourth consecutive year, flooding was the costliest overall peril at USD 62 billion. Global economic weather losses totalled approximately USD 158 billion in 2016, of which USD 45 billion were insured losses. This implies that USD 113 billion, or 72 percent, of all economic losses for weather events are uninsured.

Impact of weather events on the economy

Global economic weather loss trend

Economic weather loss-to-GDP trend

85% of increase in weather losses due to growth in economic activity and urbanization
Section 3

Capital
Underinsurance is a problem, but not all of it represents a protection gap. Stakeholders need to take a more comprehensive approach to risk management to ensure losses are being absorbed in the most efficient way.

Minimizing the social and economic costs of natural disasters is an economic and humanitarian challenge. Currently, many of these economic losses are being absorbed by the financial system and wider economy. The issue is whether these losses are being managed at the lowest cost to society in a capital efficient way.

Aon Benfield’s 2016 Annual Global Climate and Catastrophe Report highlights a familiar theme: Total economic losses continue to dwarf insured losses. This “protection gap” has received so much attention that in 2016 a new institution, the Insurance Development Forum, was established to develop partnerships and initiatives to address the issue. Even in the United States, which accounts for 56 percent of global insured losses but only 28 percent of global economic losses, the gap was nearly 50 percent in 2016.

A total cost of risk (TCOR) approach, the sum of insurance premiums, administrative risk control costs, and retained losses, could be instrumental in combatting the protection gap by identifying the most cost-effective ways to manage and reduce risk. TCOR is not a new concept, but it has yet to be widely applied to systemic problems. The 2017 Aon Global Risk Management Survey indicates that even for businesses with more than USD 25 billion in revenue, just 57 percent use TCOR to guide their risk management and insurance decisions. By integrating TCOR into disaster risk and resilience, governments and businesses will be able to allocate capital more efficiently.

A look at different scenarios, from chronic natural catastrophes to infrastructure, highlights the use of insurance, as well as financial tools beyond insurance, such as development finance, derivatives, and sovereign debt, to help economies and societies mitigate the risks that natural disasters pose. A better understanding of these dynamics can help elected officials, finance managers, policy makers, and business executives take a more prudent approach to safeguarding their interests.

Covering losses from chronic events

Natural disasters tend to be seen as singular short-term events. Some catastrophes such as drought or extreme heat, however, take time to inflict losses. In this way, the impact of such events is chronic, not acute. Drought is underreported due to a lack of data and typically uninsured. Impact Forecasting’s Catastrophe Insight team captures loss data, and one notable trend is the increase in losses from chronic events such as drought.

This dynamic doesn’t mean that the losses are not being absorbed by other financial instruments and economic players. The University of California, Davis, estimated that the agriculture industry’s economic losses during the 2015 California drought totaled USD 2.7 billion, but less than USD 500 million was insured. Of the total, direct losses accounted for USD 1.8 billion, of which USD 1.25 billion was from sources such as crop yields and associated revenue losses that were insurable. However, USD 590 million was incurred due to increased costs from pumping water and job losses, which were partially absorbed by rising food prices. While the increases were significant for certain crops, the US Department of Agriculture estimated total food price inflation at only 3.5 percent for the year. Job losses would be partially absorbed by the state through unemployment claims and a drop in demand from employers.

Assuming output losses were fully insured, operational costs would still increase to continue production. Coverage also wouldn’t lower food prices, as the lost output still exists. Instead, insurance would mitigate employment losses by helping farmers stay in business and keeping money in local economies. In agricultural markets where derivatives play a role, these products can also reduce the risk of price volatility through hedging.

So what does the protection gap, which stood at USD 156 billion in 2016, actually look like, and how do we assess the optimal role for insurance to play?
For chronic risks, derivatives are good at mitigating high-probability, low-impact events at a market level, whereas insurance is effective for low-probability high-impact events for specific circumstances. TCOR can combine risk appetites with associated administrative costs of both insurance and other financial instruments to produce an efficient frontier.

The good news is that innovation in weather data and analytics is facilitating the deployment of insurance capital to chronic events by improving the ability of insurers to price and underwrite the risk. Satellite imaging and high-resolution weather data help assess the risk of drought and the impact of the loss when it occurs. Whether insurance, derivatives, or government programs step in to absorb the economic losses, the underlying data and analytics are useful for all parties.

**Infrastructure**

Superstorm Sandy is a good illustration of underinsurance of infrastructure. In Aon Benfield’s own Sandy recap report, the total economic losses in the United States were USD 68 billion in 2012 dollars, 45 percent of which were insured. Infrastructure-related losses in the New York region alone totaled USD 22 billion, nearly a third of the total. While some of these losses were insured, the majority were not. Instead, much of this amount was absorbed by national, state, and local government. Yet in a report on the financial impact of Sandy, Fitch reported few municipal or state government downgrades resulting from the storm damage. Since fiscal challenges were localized and short term, the reaction of the wider financial markets was relatively muted. The minimal impact on the municipal and state bond markets doesn’t mean underinsurance of infrastructure is a problem that can be ignored and passed on to national governments.

Currently, many governments and development finance institutions (DFIs) can borrow at very low interest rates, often lower than the cost of insurance capital. However, government funds and/or foreign aid can be slow to materialize, sometimes taking up to six months, which delays vital redesign and reconstruction work. As parametric insurance continues to grow in sophistication and availability, these products can help speed the flow of funds and plug gaps for local and municipal governments.

As with drought, specific communities and local businesses suffer the most from damaged infrastructure. Without fully operational vital infrastructure, companies that avoid physical damage can still be affected by non-damage business interruption. The insurance industry has growing experience with the effects of cybercrime in conjunction with the development of parametric insurance solutions. This approach can be applied to disruptions caused indirectly by damaged infrastructure and offers hope that capital efficiency for small and midsize enterprises (SMEs) and critical local employers can be improved when natural catastrophes inhibit normal economic activity.
Effects on sovereign debt and the financial system

In 2015, Standard & Poor’s published a groundbreaking study on the impact of natural disasters on sovereign credit ratings. Earthquakes and tropical cyclones had the greatest impact, and the cumulative effect on creditworthiness was a combination of current sovereign debt and credit rating in addition to peril exposure. S&P notes that current insurance penetration has less of an effect on sovereign balance sheets, since so little infrastructure is insured. Financing for infrastructure by public-private partnerships is becoming more commonplace, so insurance could be increasingly important in ensuring that economic losses are absorbed efficiently.

As regulators start looking at larger systemic risks in the financial system, climate and disaster risk has been rising in importance. This year, the G20’s Financial Stability Board released recommendations on climate risk disclosure, with physical risk a key metric. Meanwhile the UK’s Insurance Advisory Council, a coalition of insurance CEOs and financial regulators, is focused on addressing resilience through finance.

Post-disaster defaults due to underinsurance have been noted, but the rates vary based on local circumstances. To date, these losses have not had a material economic impact on banks, particularly where syndication of loans is widely practiced. The impact of loan defaults on society, however, cannot be ignored, as the financial crisis of 2007–08 demonstrated. More evidence needs to be considered on how the accumulation of losses from natural catastrophes in underinsured regions affects financial institutions. Thus far, the system is performing well but this could change should there be a future climate disaster event on a greater scale to those yet seen.

Toward efficient risk transfer

Insurers need to harness the full range of products and options, understand how uninsured losses affect economies of different scales, recognize where other financial solutions have value, and educate clients on TCOR. SMEs and households in particular need more engagement from the industry to help them think about TCOR on a smaller scale. Underinsurance is a problem, but not all of it represents a protection gap. Better engagement with financial institutions and governments at every scale is needed, and the Insurance Development Forum is a good start.

Insurers are well-placed to focus on chronic risks and find new ways to offer financial protection to infrastructure. Technology and innovation are creating new ways of pricing and transferring risk, and analytics can help assess risk and determine where insurance makes sense. Only through innovation can economies and societies absorb the economic losses of disasters in an efficient way. Closing the capital efficiency gap is critical not only to our industry but also to the lives and livelihoods of the global population.
Risk-Adjusted Underwriting Returns

Insurers can improve their capital allocation by learning from successful CEOs in other industries.

In his book, The Outsiders: Eight Unconventional CEOs and Their Radically Rational Blueprint for Success, William Thorndike Jr. profiles eight CEOs whose track record, as measured by total stock price return, far exceeded the performance of the overall market and their peer groups. Even though the CEOs were from different industries and eras, Thorndike noticed several common traits. The strongest thread tying them together was their single-minded focus on appropriate capital allocation. Thorndike writes, “These executives were capital surgeons, consistently directing available capital towards the most efficient, highest-returning projects. Over long periods of time, this discipline had an enormous impact on shareholder value.” They recognized their primary job was to be stewards of the capital that shareholders had entrusted to them. In summarizing how the CEOs achieved this objective, Thorndike provides a checklist for making effective decisions on resource allocation. The rest of this article will focus on two of the initial items from this checklist—target hurdle rate and risk adjusted returns—and apply the approach to an insurance example, drawing on information provided in the report’s companion volume.

Target hurdle rate
“Start by determining the hurdle rate—the minimum acceptable return for investment projects”

To allocate capital effectively, we must have a yardstick to measure against. This “hurdle rate” should be determined relative to the set of opportunities available to the company. Often the hurdle rate is equal to the company’s weighted average cost of capital (WACC). The graph shows the WACC for publicly traded P&C (re)insurers is around 8 percent using the capital asset pricing model (CAPM). For mutual insurers, the cost of capital is more difficult to estimate since they do not have to achieve a return that satisfies the expectations of equity holders. Surplus notes do provide a reference point for the cost of debt capital, which can be used alongside traditional metrics for publicly traded companies to estimate a mutual insurer cost of capital.

For publicly traded companies, the return implied from repurchasing their own stock is another important benchmark. If operating returns do not exceed this implied return, then capital should be returned to shareholders—something at which the Outsider CEOs excelled. In current market conditions, the implied return on share repurchases for publicly traded (re)insurers is in the range of 9 to 15 percent.

(Re)insurer cost of capital (percent)

<table>
<thead>
<tr>
<th>(Re)insurer cost of capital (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="Image" alt="Graph showing cost of equity, cost of debt, and total cost of capital over time" /></td>
</tr>
</tbody>
</table>

Implied return on share repurchases

<table>
<thead>
<tr>
<th>Return on equity</th>
<th>Price-to-book ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.1x</td>
</tr>
<tr>
<td>6%</td>
<td>27%</td>
</tr>
<tr>
<td>8%</td>
<td>47%</td>
</tr>
<tr>
<td>10%</td>
<td>67%</td>
</tr>
<tr>
<td>12%</td>
<td>87%</td>
</tr>
</tbody>
</table>

*Assumes 3% after tax investment return.
**Risk-adjusted returns**

“Calculate returns for all internal and external investment alternatives and rank them by return and risk”

Once a hurdle rate is determined, we can estimate the risk-adjusted returns for our investment opportunities—illustrated here using underwriting operations. We will use information provided in the report’s companion volume to calculate a return on risk-adjusted capital (RORAC) by line for a hypothetical US company writing eight lines of business, each with premium volume of USD 100 million.

**Return**

The numerator of the RORAC calculation is the total income generated from a given line of business. This amount includes the underwriting income plus investment income earned on both policyholder supplied funds and the capital supporting the line. To develop the expected underwriting inputs, we used a three-year average of the median combined ratio by line of business from US annual statement data by company. For simplicity, the investment return is assumed to be a constant 2 percent.

**Illustrative insurer inputs**

<table>
<thead>
<tr>
<th>Line</th>
<th>Premium</th>
<th>Expense ratio</th>
<th>Loss ratio</th>
<th>Combined ratio</th>
<th>Loss ratio CV</th>
<th>Loss pattern duration (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto physical damage</td>
<td>100</td>
<td>26%</td>
<td>74%</td>
<td>100%</td>
<td>17%</td>
<td>0.8</td>
</tr>
<tr>
<td>Commercial auto liability</td>
<td>100</td>
<td>30%</td>
<td>74%</td>
<td>105%</td>
<td>23%</td>
<td>2.6</td>
</tr>
<tr>
<td>Commercial multi-peril</td>
<td>100</td>
<td>34%</td>
<td>64%</td>
<td>98%</td>
<td>35%</td>
<td>2.3</td>
</tr>
<tr>
<td>Homeowners</td>
<td>100</td>
<td>29%</td>
<td>62%</td>
<td>90%</td>
<td>80%</td>
<td>0.9</td>
</tr>
<tr>
<td>Other liability occurrence</td>
<td>100</td>
<td>29%</td>
<td>65%</td>
<td>94%</td>
<td>37%</td>
<td>4.8</td>
</tr>
<tr>
<td>Private passenger auto liability</td>
<td>100</td>
<td>25%</td>
<td>79%</td>
<td>104%</td>
<td>14%</td>
<td>1.9</td>
</tr>
<tr>
<td>Special property</td>
<td>100</td>
<td>30%</td>
<td>55%</td>
<td>85%</td>
<td>84%</td>
<td>0.9</td>
</tr>
<tr>
<td>Workers’ compensation</td>
<td>100</td>
<td>25%</td>
<td>74%</td>
<td>98%</td>
<td>26%</td>
<td>4.9</td>
</tr>
<tr>
<td>Total</td>
<td>800</td>
<td>28%</td>
<td>68%</td>
<td>97%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

**Capital**

“The Outsider CEOs believed that the value of financial projections was determined by the quality of the assumptions, not by the number of pages in the presentation”

Estimating required capital by insurance line of business is an inherently paradoxical exercise: in reality, every dollar of insurer capital sits behind every policy. Yet to make informed investment decisions we need to estimate what each unit contributes to the overall capital need. This exercise has an extensive body of actuarial literature, but our practical approach focuses on key assumptions.

The capital required to support a line of business is a function of four interrelated elements: premium volume, volatility, duration of loss payout, and correlation to other risks.

- **Premium volume**: The premium volume sets the absolute scale of each line. In addition, both volatility and correlation vary by premium volume.
- **Volatility**: This metric is the primary driver of stand-alone required capital. The more volatile a line of business, the more capital needed to support it. The report’s companion volume measures underwriting volatility as the coefficient of variation (CV) of historical loss ratios. This calculation reflects the realized volatility observed through time by line of business. Volatility is a function of many underlying factors, including: size of book of business, policy limits, industry classes, geography, and catastrophe exposure. Our analysis uses the CVs for US lines provided in the companion volume. Note that since these CVs are based entirely on historical data, we are not using output from a vendor catastrophe model for property lines. Therefore, the analysis shown here will understate the true volatility of property lines.

- **Duration of loss payout**: After insurers have written a risk, they need to hold capital for that risk until its losses are fully paid. Up until that point, there is still a risk that they will have to pay more in losses than anticipated (also known as loss reserve risk). To reflect reserve risk in our capital estimates, the loss cash flows are adjusted to reflect the length of the payout pattern, which we estimate by line from historical loss triangles. All else equal, the longer it takes to fully pay out losses, the more capital is required to support the risk.

- **Correlation**: Correlation reflects the relationship between the modeled loss ratios by line. Similar to volatility, many underlying factors influence the correlation of loss ratios. Correlation estimates require large amounts of data to be credible, underscoring the value of the correlation matrices provided in the companion volume. The diversification benefit is determined by the level of correlation assumed across lines.

For illustration purposes, we assume a lognormal distribution for loss ratios and use the 99.5 percent (200-year) value-at-risk (VaR) measure for required capital.

The volatility of the property lines—homeowners and special property—is reflected in their high capital charge per dollar of premium. They have the highest pricing risk of all the lines. The long tail nature of other liability occurrence and workers’ compensation is reflected in the larger amount of reserve risk. The auto lines have lower risk and thus the lowest capital requirements.

### Stand-alone capital charge per dollar of premium

<table>
<thead>
<tr>
<th>Line</th>
<th>Pricing risk</th>
<th>Reserve risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeowners</td>
<td>0.19</td>
<td>0.50</td>
</tr>
<tr>
<td>Special property</td>
<td>0.21</td>
<td>0.40</td>
</tr>
<tr>
<td>Other liability occurrence</td>
<td>0.40</td>
<td>0.70</td>
</tr>
<tr>
<td>Workers’ compensation</td>
<td>0.53</td>
<td>1.04</td>
</tr>
<tr>
<td>Commercial multi-peril</td>
<td>0.53</td>
<td>1.04</td>
</tr>
<tr>
<td>Commercial auto liability</td>
<td>0.53</td>
<td>1.04</td>
</tr>
<tr>
<td>Private passenger auto liability</td>
<td>0.53</td>
<td>1.04</td>
</tr>
<tr>
<td>Auto physical damage</td>
<td>0.53</td>
<td>1.04</td>
</tr>
</tbody>
</table>

### Diversified capital charge per dollar of premium

<table>
<thead>
<tr>
<th>Line</th>
<th>Pricing risk</th>
<th>Reserve risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special property</td>
<td>0.19</td>
<td>0.50</td>
</tr>
<tr>
<td>Homeowners</td>
<td>0.21</td>
<td>0.40</td>
</tr>
<tr>
<td>Other liability occurrence</td>
<td>0.40</td>
<td>0.70</td>
</tr>
<tr>
<td>Commercial multi-peril</td>
<td>0.53</td>
<td>1.04</td>
</tr>
<tr>
<td>Workers’ compensation</td>
<td>0.53</td>
<td>1.04</td>
</tr>
<tr>
<td>Commercial auto liability</td>
<td>0.53</td>
<td>1.04</td>
</tr>
<tr>
<td>Auto physical damage</td>
<td>0.53</td>
<td>1.04</td>
</tr>
<tr>
<td>Private passenger auto liability</td>
<td>0.53</td>
<td>1.04</td>
</tr>
</tbody>
</table>
Return over capital
Now the return and capital amounts can be combined to estimate return on risk-adjusted capital by line. For the illustrative insurer, workers’ compensation, special property, and other liability occurrence achieve a return greater than the estimated hurdle rate. For the lines that do not meet this threshold, insurers can take actions to improve the returns through pricing increases or reducing required capital, such as by purchasing additional reinsurance.

(Re)insurers do not have an easy task in following the example of the Outsider CEOs. Insurance underwriting returns are by their nature difficult to risk-adjust—the true cost of goods sold isn’t known at the time of sale. However, the framework outlined in this article, along with the information in the companion volume, provide a foundation that can help insurance executives to be effective “capital surgeons.”

Components of RORAC

<table>
<thead>
<tr>
<th>Line</th>
<th>Allocated capital</th>
<th>Premium-to-capital</th>
<th>Investment return on capital</th>
<th>Underwriting return on capital</th>
<th>Total return on capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers’ compensation</td>
<td>65,706</td>
<td>1.5x</td>
<td>9.6%</td>
<td>1.6%</td>
<td>11.2%</td>
</tr>
<tr>
<td>Special property</td>
<td>120,738</td>
<td>0.8x</td>
<td>2.2%</td>
<td>8.2%</td>
<td>10.4%</td>
</tr>
<tr>
<td>Other liability occurrence</td>
<td>104,008</td>
<td>1.0x</td>
<td>5.9%</td>
<td>4.0%</td>
<td>9.9%</td>
</tr>
<tr>
<td>Homeowners</td>
<td>117,727</td>
<td>0.8x</td>
<td>2.3%</td>
<td>5.3%</td>
<td>7.6%</td>
</tr>
<tr>
<td>Auto physical damage</td>
<td>21,368</td>
<td>4.7x</td>
<td>5.9%</td>
<td>1.1%</td>
<td>7.0%</td>
</tr>
<tr>
<td>Commercial multi-peril</td>
<td>69,902</td>
<td>1.4x</td>
<td>4.6%</td>
<td>1.7%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Commercial auto liability</td>
<td>52,850</td>
<td>1.9x</td>
<td>6.7%</td>
<td>-5.6%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Private passenger auto liability</td>
<td>19,123</td>
<td>5.2x</td>
<td>12.2%</td>
<td>-12.9%</td>
<td>-0.7%</td>
</tr>
<tr>
<td>Total</td>
<td>571,420</td>
<td>1.4x</td>
<td>4.9%</td>
<td>3.1%</td>
<td>8.0%</td>
</tr>
</tbody>
</table>

*2 percent investment yield; 35 percent tax rate on underwriting income, 15 percent tax rate on investment income.
InsurTech Start-Ups Are Making Waves

Investors are committing billions of dollars to insurance start-ups with the potential to transform the insurance industry. Incumbents would be wise to pay attention and consider collaborations as well as partnerships.

The traditional insurance industry has been relatively slow to embrace digital technology compared with other industries. That reticence has opened a window of opportunity for entrepreneurs to deploy digital technology to improve the customer experience through a host of start-up companies. They are using telematics, connected devices, and mobile technology in personal lines and, increasingly, in commercial lines as well. This has allowed the start-ups to not only provide more effective solutions, but also to continuously improve them through the collection and analysis of data.

The InsurTech space to-date has USD 14 billion in cumulative investments in more than 550 start-up companies. Some incumbent insurers have invested in them. These firms have business models or innovative technologies focused on extracting savings and efficiencies from the current industry model and addressing changing customer preferences and demands. They typically focus on either property and casualty or the life and health sectors. In monitoring their activity, we see consistent themes developing regarding which parts of the insurance value chain will most likely be affected within those sectors.

More than 55 percent of start-ups are seeking to change how customers interact with insurance companies and purchase products. According to an Accenture study, 40 percent of consumers are unhappy with their coverage and are willing to switch to a new service provider. The start-ups are building consumer-centric online marketplaces where individuals can easily receive multiple insurance quotes from a single point of contact. They are also looking to redefine the products consumers are buying. Examples include:

- **B2C insurance marketplace and B2B digital brokers:** These models offer online or mobile applications to provide a single point of contact for customers to get multiple insurance quotes. This space is crowded with more than 100 companies, such as Zhong An, China’s online-only P&C insurer; Goji, an online insurance agency that lets consumers search for personal coverage; CoverHound, a B2C price comparison platform for consumers to shop for auto insurance; Oscar, a health insurance company; Insureon, a B2B online broker for small business insurance; and SimplyInsured, a group health insurance broker for small businesses.

- **Health navigators:** These companies seek to offer participants ways to engage in and navigate through the healthcare system—from benefits enrollment to getting and staying healthy to ultimately finding the right care with good information. More than 140 companies span the value chain, such as Jiff, a digital navigation platform that offers incentives to employees who use the solution that creates most value; Welltok, a health optimization platform; Accolade, a late-stage consumer healthcare engagement company; and Omada Health, a community-based platform providing online behavior change programs.

- **Affinity/peer-to-peer:** To reinvent the traditional insurance model, start-ups are creating a risk-sharing network of like-minded individuals. This category has about 40 companies such as Friendsurance, a German–based firm that allows groups of people to pool insurance premiums and offers annual no-claims rewards, using social networks to bring customers together; and Bandboo, a recent Singapore-based startup leveraging blockchain technology for self-managing communities to pool risk.

- **Microduration coverage:** These products feature on-demand insurance sold for a defined period of time. Players include Trov, a platform to provide insurance for individual items, and Slice, insurance for Uber and Lyft drivers. Cuvva insures drivers on a short-term basis on any vehicle. In an attempt to accommodate the growing trend of people sharing rather than owning vehicles, Cuvva provides coverage for only the hour(s) or days that they require it.
In addition to the focus on the consumer, other start-ups are harnessing technology, big data, and machine learning to create insurance-specific solutions in a number of areas:

- **Telematics/Internet of Things (IoT):** Companies are seeking to use information and communications technology to change the basis for underwriting and pricing of risk, as well as provide continuous monitoring that enables customers to mitigate exposure to losses before they happen. Examples include Zubie, a connected auto hardware device and free app that provides real-time location; and HumanAPI, a healthcare IoT platform that aggregates, normalizes, and stores data from multiple sensors. Neos is a company that uses connected devices to monitor the home for break-ins, fires, and leaks, and also provides an insurance policy if a loss occurs. With the financial backing of numerous insurers, Neos has been able to provide a product that isn’t just bought and forgotten until a claim arises. Instead, using the combination of connected devices (monitored on mobile devices) and insurance coverage, the customer experience has become a continuous engagement that addresses both loss prevention and risk transfer.

- **Artificial intelligence/machine learning/workflow technologies:** Businesses are using advanced analytics to speed workflow processing and claims handling to make better decisions. Examples include DataRobot, a machine learning platform that can support the development of predictive models; and Snapsheet, which provides a mobile phone–based claims solution for auto insurers that streamlines the process for customers to manage auto repair estimates and bidding. AI is another technology that is playing more of a role in better understanding and servicing clients. Companies like Lemonade are using chatbots, a form of AI that simulates a conversation with human users, to replace lengthy forms which arguably improve the customer experience. When a Lemonade client makes a claim, AI is used to check if the claim is fraudulent.

While many of the start-ups are focused primarily on insurance, several companies in related industries have developed products and solutions that have applicability to the insurance sector. Geospatial imagery technologies initially designed for hedge funds, retail, and agriculture are disrupting insurance. Orbital Insights, for example, uses satellite imagery for retail, agriculture, and property insurance. Companies such as Pypestream, which deploys chatbots and natural language processing to automate and simplify call center processes, are beginning to apply these solutions to insurance. And enterprises such as Airware are exploring how drones can be used to support insurance underwriting and claims activities.

Notwithstanding the innovation to date, there is much still to come. Think insurance marketplaces, to name one area, where comparisons are based on price—the challenge here is to extend to include comparisons of coverage (ACV vs RCV, items excluded, etc.) in a way that doesn’t detract from the simplified user experience already developed.

Funding for these InsurTech companies is coming from four sources: angel/seed investors, generalist/tech venture capital funds (for example, Andreessen Horowitz, GV, and Sequoia), venture capital funds concentrated in InsurTech and FinTech (such as Arbor Ventures, Peate Ventures, FinTech Collective, and Manchester Story), and incumbent insurance companies.

The pace of change in the insurance industry is accelerating—from how customers purchase coverage, to what information is available to evaluate risk, to how capital providers engage. The pressure on insurers to innovate is clearly growing, and capital is flowing into the insurance sector as investors see an opportunity to disrupt the more than USD 5 trillion marketplace. It’s imperative for incumbents to closely monitor the InsurTech start-up space and be ready to invest when they identify a promising technology or business model.
InsurTech companies span a variety of business models and offerings

**Enabling Technologies**

- Internet of Things
- AI/Machine Learning
- Drones/Robotics
- Blockchain
- Advanced Analytics & Workflows

- Extract savings and efficiencies from current industry business models
- Address changing customer preferences and demands

**Risk**

**Health**

**B2C Insurance Marketplace**

- ZhongAn Insurance
- Goji
- CoverHound
- Oscar

**B2B Digital Brokers**

- insureon
- SimplyInsured

**Affinity/Peer to Peer**

- Lemonade
- bandboo

**Micro-duration coverage**

- trōv
- Slice

**Health navigators**

- Jiff
- Welltok.
- Accolade
- omada

**Telematics/Internet of Things**

- Zubie
- HUMAN API

**AI, Machine Learning, and Workflow Technologies**

- DataRobot
- AiDA
- snapsheet
Cyber risk can be viewed many ways, but one that is particularly relevant for managing insurance accumulations is to look at the common aggregation paths shared across a portfolio.

The above shows the distribution of expected losses against the “portfolio” of Fortune 500 companies due to two kinds of major aggregation paths: software and technology service providers.

Across industries, operating systems generate the greatest exposure, largely due to the number of vulnerabilities identified within each OS and the relatively few operating systems available for enterprise-wide deployment.

Notable differences can be seen between industries, and the height of each row is proportional to the industry’s level of total risk. Some industries are more exposed to cloud providers than others. Given the business models for Utilities and Healthcare, it makes sense that these industries are less exposed to cloud. The significance of cloud on Manufacturing may seem surprising. It is important to note that Manufacturing includes a wide variety of firms including tech-oriented companies, and many manufacturers rely heavily on internet connectivity to design their wares.

This chart illustrates contingent business interruption from service providers as an important potential driver of cyber insurance portfolio risk.
Section 4

Data & Analytics
Aggregating data from new and non-traditional sources will enable the use of more sophisticated models for casualty catastrophes.

In our 2015 report, we discussed corporate "giga losses," also known as casualty catastrophes—corporate liability events with settlements in excess of USD 1 billion. We presented a simple model to estimate the frequency of such events: divide the loss level in billions into five. Thus the estimated frequency of a USD 100 billion event—about the current estimate of insured loss for US asbestos exposure—is 5 percent. The comparable return period for a US wind event is just 2 percent. Despite the significant risk posed by casualty catastrophes to both corporations and insurers, substantially more research has been poured into developing models to quantify the risk of property catastrophes. Similarly, regulators and ratings agencies have focused on this category, leading to a significant difference in capital requirements for the two risks. This disparity contributes to the insurance market’s underdevelopment for large-limit corporate liability covers and often leaves insurers guessing as to their level of exposure to casualty catastrophes. However, since our 2015 report, the gaze of both modelers and regulators has shifted towards this neglected risk.

Defining the problem

A.M. Best defines a casualty catastrophe as "an event, activity, or product that results in a large number of lawsuits from multiple plaintiffs alleging damages that impact multiple insureds, coverages, and/or time periods." This definition highlights several of the key differences between casualty and property catastrophes that make the former difficult to model.

- **The human element:** Property catastrophes follow physical laws that allow experts to build reasonable models. Casualty catastrophes do not have this luxury, as their sources and dynamics do not exhibit a consistent pattern. The legal system is complex and difficult to model, yet it plays an essential part in every casualty catastrophe. The unpredictability of judges and juries and the tenaciousness of lawyers seeking class action lawsuits exceed even what mother nature can produce.

- **Availability of historical data:** A model is only as good as the data used to develop it. US hurricane models draw on more than 100 years of available data, but historical data are limited for casualty catastrophes, especially beyond the past three decades.

- **Disparate and unknown causes of loss:** Casualty catastrophes can result from a sudden event, such as the Deepwater Horizon explosion, or from an event that remains latent for many years and then unfolds slowly over time, such as asbestos in the United States. Property catastrophes caused by natural disasters do not have this level of variety; instead they are almost always sudden, known events.

- **Aggregation across policy years:** The potential latency of a casualty catastrophe results in the aggregation of policy years subject to the catastrophe liability event. The use of claims-made policy forms helps mitigate this risk, but for the lines that predominantly use occurrence forms, this latency remains an important consideration in casualty catastrophe modeling.

- **Clashes across multiple industries, insurance lines of business, and geographies:** The systemic nature of many casualty catastrophe risks can result in significant clash losses across several dimensions. For example, in the case of a product liability event, the entire supply chain of the product could be at risk—from the component part manufacturers to the ultimate retail distributor.

The current state of play

The basic conceptual framework for natural catastrophe modeling can also be applied to casualty catastrophes:

- **Hazard:** Identify events that could occur and model their event generation and characteristics by using historical data and forward-looking research.

- **Vulnerability:** Given the event and the insured’s risk profile, estimate potential economic loss amounts.

- **Financial:** Apply coverage terms, including allocation of loss by insurer and policy year, to estimate insured loss.

The initial focus of casualty catastrophe modeling is on data collection, both historical loss data and insured exposure information. Once accurate exposure information is collected, insurers can begin quantifying their casualty catastrophe risk. The complexities of this risk make it difficult to jump immediately to a fully stochastic model similar to the current natural catastrophe models. Instead, a rigorous deterministic, scenario-based method must first be established before embarking on a more complex modeling exercise.
Progression of modeling approaches

**Deterministic**
- Focus on developing a deterministic set of scenarios to evaluate against portfolio
- Less data required
- Create for emerging risks, not just events that occurred in the past

**Stochastic—Top down, actuarial**
- Use traditional actuarial frequency-severity methodology based on historical data
- Assumes that historical data is a reasonable proxy of future risks

**Stochastic—Bottom up**
- Model the process by which risks emerge over time
- Focus on emerging risks not seen in the past
- Inherently less historical data to use in estimating parameters

Two modeling vendors have made great strides in developing models that are towards the “Stochastic—Bottom up” modeling approach.

Arium, a part of AIR Worldwide, uses an approach based on network theory to model scenarios on both a deterministic and stochastic basis. In partnership with Lloyd’s of London, Arium developed a methodology that creates liability “storm tracks” as a new way to analyze casualty catastrophe events. The methodology classifies events into “shapes,” which characterize the supply chain elements and economic parameters associated with each event type. The corporate shape, for example, applies to historical events such as the Enron bankruptcy, while the infrastructure/operational shape resembles the Deepwater Horizon event. These shapes form the building blocks for both deterministic and stochastic modeling for potential casualty catastrophes.

Praedicat, backed by the RAND Corporation and RMS, takes a forward-looking approach by text-mining scientific journals and regulatory reports to identify and quantify emerging risks. Using this information and other historical data, Praedicat employs a bottom-up stochastic model to estimate the risk of future loss. For example, Praedicat’s algorithms mined 2,847 peer-reviewed articles about bisphenol A (BPA) causing bodily injury since 1960. Of those, 85 percent reported harmful effects, and 18.8 percent included studies on humans. This information is used to build an exceedance probability curve for potential losses associated with this risk. The full event set includes more than 10,000 potential future mass litigation events.

Sample emerging risks

<table>
<thead>
<tr>
<th>Risk</th>
<th>Description</th>
<th>Potential impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bisphenol A (BPA)</td>
<td>An organic synthetic compound employed to make certain plastics and epoxy resins; used in water bottles, food and beverage cans, sports equipment, CDs, and DVDs.</td>
<td>May have negative effects on the brain, behavior, and prostate gland of fetuses, infants, and children</td>
</tr>
<tr>
<td>Nanotechnology</td>
<td>The understanding and control of matter at dimensions between approximately 1 and 100 nanometer (nm). Used in food packaging, agriculture, and tennis balls.</td>
<td>Ingestion of sufficient amounts could cause health issues such as mesothelioma</td>
</tr>
<tr>
<td>Silica</td>
<td>A chemical compound that is an oxide of silicon found in nature as quartz. Found in commercial glass, optical fibers, and food additive.</td>
<td>Inhaling finely divided crystalline silica dust can lead to silicosis, bronchitis, or cancer</td>
</tr>
</tbody>
</table>
Impact on capital

Given the current state of casualty catastrophe modeling, the explicit impact of these events on insurer capital has been minimal to date. However, several regulators and rating agencies are now requesting explicit quantification of casualty catastrophes. In addition, some insurers are beginning to model casualty catastrophes as a separate risk charge within their internal capital frameworks. The table below summarizes the current state of casualty catastrophe risk under several common insurance capital standards.

### Capital standards and casualty catastrophes

<table>
<thead>
<tr>
<th>Capital standard</th>
<th>Explicit risk charge</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.M. Best</td>
<td>No</td>
<td>Five deterministic scenarios</td>
<td>Ask companies to provide as part of SRQ</td>
</tr>
<tr>
<td>IAIS Global Capital Standards</td>
<td>Yes</td>
<td>Factor-based</td>
<td>Explicit charge reflecting “mass tort” risk</td>
</tr>
<tr>
<td>Solvency II</td>
<td>Yes</td>
<td>Factor-based; internal model</td>
<td>Liability risk part of man-made catastrophe risk component</td>
</tr>
<tr>
<td>S&amp;P</td>
<td>No</td>
<td>n/a</td>
<td>No explicit quantification of casualty catastrophe risk requested</td>
</tr>
<tr>
<td>US NAIC</td>
<td>No</td>
<td>n/a</td>
<td>No explicit quantification of casualty catastrophe risk requested</td>
</tr>
<tr>
<td>Internal capital model</td>
<td>Some</td>
<td>Both</td>
<td>Deterministic scenarios most common; limited use of stochastic</td>
</tr>
</tbody>
</table>

Any explicit reflection of casualty catastrophe risk in capital frameworks could have a meaningful impact on capital levels. To develop a rough estimate, we use our simple model estimate of a 5 percent chance of a USD 100 billion event as the basis for an industry-wide casualty catastrophe risk charge. If we assume an average payout of 10 years and a discount rate of 3 percent, the discounted casualty catastrophe risk charge is approximately USD 75 billion. A risk charge of this magnitude could increase required capital across the industry by 5 to 10 percent depending on the specific implementation details.

The future

Just as natural catastrophe modeling did over the past 30 years, we expect casualty catastrophe modeling to improve by leaps and bounds over the next 30 years. However, this progress will occur only if the industry collects the necessary data and if all the key parties—insurers, model vendors, regulators, and rating agencies—continue to put more resources toward quantifying this risk.

In the short term, insurers can take the following steps to improve their understanding of this risk:

- Gather by-policy exposure data
- Understand exposure aggregations across industries and lines of business
- Develop and apply stress scenarios to estimate potential losses
- Monitor emerging risks and your potential exposure to them; be prepared to react quickly
- Evaluate modeling approaches as they continue to evolve

Although much work remains to be done, insurers that take these no-regrets actions will gain a better understanding of casualty catastrophes as the risk models evolve.
Evolution of Cyber Risk Modeling Methods

The insurance industry is ready to advance in its management of cyber risk using cutting edge data and analytics.

The cyber insurance market is now nearly 20 years old, but is often discussed as though it is a relatively new phenomenon. And much of this perception of newness is well-deserved; cyber risks continue to evolve, and insurance coverages keep changing along with them.

This continued evolution creates challenges for modeling, and nowhere is this more important than in the work of aggregation management. Events such as the recent WannaCry and NotPetya attacks, Amazon's S3 cloud outage, and the denial-of-service attack against Dyn DNS all serve as reminders of this looming threat—and all these events occurred just in the last 12 months.

When discussing cyber risk modeling, we hear a litany of often-repeated truisms about its difficulty: lack of data, evolving threats, active adversaries, and serious systemic risk potential. Certainly, cyber risk presents real challenges for modelers.

But methods are emerging to manage the evolving chaos of cyber threats and to formulate a framework for managing cyber aggregation risk. Let us survey these efforts.

Debunking a myth

First, while the truisms mentioned above are broadly accepted, we believe one of them deserves to be challenged: the lack of data to quantify cyber risk. True, no publicly available multi-decade dataset of cyber insurance claims exists, and few insurers have data spanning beyond 10 years—even those who do must question its utility as cyber threats evolve. But consider the following:

- Cisco scans of 600 billion e-mail messages daily, and identifies 1.5 million unique kinds of malware every day.
- Public cloud providers have a massive number of servers—the modeling company Cyence observes that Amazon data centers in the US alone have up to 32 million IP addresses used for their cloud services.
- Our Stroz Friedberg colleagues actively observe & track more than 1 billion records from leaked databases that have been made available following cyber security incidents.
- Our database of known cyber incidents measures more than 45,000—and growing each month.

These statistics, plus terabytes of new data on threats and vulnerabilities created each day, point to an important truth: there is an enormous amount of data for analyzing cyber risk. What is perhaps new and different for the insurance industry, though, is that this data is largely collected by technology firms, specifically those in the cybersecurity sector—not by traditional insurers. But such information is necessary to grasp the problem at hand, so it behooves our industry to seek out partnerships with providers of the data, where it can be gathered.

Understanding the scenario

As with terrorism modeling, the most widely-embraced approach to cyber risk modeling has been to start with deterministic scenarios of cyber disaster. Common scenarios include, but are not limited to: a cloud service provider outage, a mass vulnerability leading to data breaches or extortion threats, a large-scale distributed denial-of-service (DDoS) attack, and disruption or damage to critical infrastructure such as power generation or the internet itself. These scenarios could be caused by malicious actors, or in some cases equally by accident or mistakes—as seen with the Amazon outage earlier this year.

Once scenarios are identified that are seen to impact an insurer’s portfolio, the next step is to evaluate the potential damages. Here, we see a wide divergence of methods. Scenarios are most credible when they use granular, company-level information to reflect individual insureds’ susceptibility to losses.

Initially, modeling companies expected insurers to populate the models with this kind of information for each policy—for example, the hourly cost of website downtime to each insured’s company. But insurers commonly use policy systems that were designed long before cyber risk was a priority, making it difficult to capture cyber exposure data. And in many cases the insureds themselves may not be able to gather or provide this information during the underwriting process. Increasingly, modeling companies see part of their value in being able to identify these data points about insureds, or to make reasonable estimates to fill in gaps.
Beyond scenarios

Deterministic scenarios are only the beginning of an approach to quantifying cyber risk. Without being able to assign probabilities and evaluate the return period of an event, insurers do not know if they are evaluating a worst-case scenario or a very routine one – and this can make the difference between profitability and loss. At a recent conference, cyber insurance practitioners broadly acknowledged that product pricing currently does not make any specific provision for a catastrophe load. So we need frequencies to advance modeling.

Once again we believe that insurers, in partnership with technology companies, have access to a great deal more data than one might expect. While at the time of this writing we have yet to see the “Hurricane Andrew” of cyber risk, sufficient data is available about commonly-considered event types to estimate the probability of more severe versions of these scenarios.

Lloyd’s recently set an important milestone: in conjunction with Cyence, Lloyd’s released two new scenarios that examine affirmative cyber loss probabilistically. These scenarios—an outage at cloud service providers and a mass vulnerability causing data breaches—were calculated at 50-year and 200-year return periods based on a significant amount of underlying data about the exposures, vulnerabilities, and loss drivers at the company level, which roll into the aggregate loss estimates.

Of these scenarios, the cloud outage dominates at the 200-year return period, which would correspond to a 2.5- to 3-day outage. With economic losses exceeding USD 50 billion, this scenario would generate losses seen by only a handful of events in the natural catastrophe world; Hurricanes Katrina and Sandy generated USD 155 billion and USD 75 billion in economic loss, respectively, and five earthquakes have exceeded USD 50 billion led by the 2011 Tohoku quake at USD 229 billion.

Yet at the same time, these cyber losses are relatively modest. In Cambridge University’s 2015 Business Blackout paper, it was estimated that a cyber attack on the US east coast power grid would generate USD 243 billion in economic losses in the base case, with losses up to USD 1.02 trillion in the extreme case.

“Silent” cyber exposure, such as the blackout scenario, is a very real concern for the industry. But again, without probabilities assigned to such large-scale events, such a scenario may draw attention away from events that are more likely to cause real losses to businesses and their insurers. By adding a probabilistic framework to contemplate cyber aggregations, we see Lloyd’s and Cyence as having advanced the industry’s reckoning with cyber risk. Contact Aon Benfield to find out more about how these scenarios would impact your cyber portfolio.

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**Cyber scenario losses by return period (USD billions)**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Insured Loss</th>
<th>Uninsured Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud service providers, 1:50 Years</td>
<td>$4.6B</td>
<td>$53.1B</td>
</tr>
<tr>
<td>Cloud service providers, 1:200 Years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass vulnerability, 1:50 Years</td>
<td>$9.7B</td>
<td></td>
</tr>
<tr>
<td>Mass vulnerability, 1:200 Years</td>
<td></td>
<td>$28.7B</td>
</tr>
</tbody>
</table>

Source: Lloyd’s, Cyence
Putting cyber in context

It may help to evaluate cyber risk using a methodology shared with traditional lines of insurance. For that we can use the framework of the companion volume of this study. Cyber risk is reported in the US as part of other liability—claims made business, which on the whole carries a systemic risk factor of 39 percent—i.e. a 39 percent coefficient of variation in insurer gross loss ratios. Property reinsurance business, as a catastrophe-driven product line, shows a systemic risk factor of 85 percent. These are just two benchmarks that we could use.

By evaluating a diversified group of companies with typical policy limits and retentions, we can estimate the systemic risk potential for cyber insurance. Using the Fortune 500 companies as a hypothetical diversified portfolio, we calculate a coefficient of variation (CV) ranging from 65 to 70 percent, which has shown to be fairly stable across the testing we have done. This is pure loss volatility. If we add underwriting cycle volatility comparable to other liability claims-made, this would give us a CV for cyber in the range of 90 to 100 percent.

This would make cyber insurance one of the most volatile property-casualty lines of business—somewhat more volatile than property reinsurance but not nearly as volatile as financial guaranty losses which spiked following the 2008 financial crisis. While cyber risk certainly generates concern for many insurers, we believe it helps to put bounds around the problem and begin to think pragmatically about the real drivers of the risk, and ways to formulate diversification strategies. And of course many insurers today benefit from cyber insurance still being quite small relative to their capital base.

We are excited by the recent advances in cyber risk modeling, and look forward to seeing further growth in this emerging property-casualty line, backed by sophisticated analytics and risk management.

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**Estimation of systemic cyber risk volatility versus selected lines** (coefficient of variation of gross loss ratio)

<table>
<thead>
<tr>
<th>Line</th>
<th>No underwriting cycle risk</th>
<th>All risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other liability - claims-made</td>
<td>27%</td>
<td>39%</td>
</tr>
<tr>
<td>Reinsurance - property</td>
<td>54%</td>
<td>85%</td>
</tr>
<tr>
<td>Cyber</td>
<td>65%-70%</td>
<td>90%-100%</td>
</tr>
</tbody>
</table>
Analytics and the Underwriting Transformation

Automated machine learning is supplementing human decision making, which is giving organizations an opportunity to reconfigure. Underwriting will evolve as a consequence.

Insurers are under increased pressure to deliver competitive returns in a low rate environment. At the same time, advances in data, analytics, and technology are presenting opportunities to automate tasks and free up experts to concentrate on higher-value areas. Insurance executives must attract the right talent and build internal capabilities to take full advantage of these technologies. Once they have this foundation in place, they can then determine a strategy for how to extract the most value out of the underwriting function. Insurers can chart a more productive, sustainable approach by determining where underwriters’ expertise and judgment can have the greatest impact, as well as how analytics can support this goal.

Analytics talent supply and demand
In a recent Ward Group survey of insurance company executives, 25 percent of respondents “strongly disagreed” or “disagreed” that they have the analytics and big data capabilities and skills required to meet future business priorities. In addition, 70 percent of companies identified “human capital/talent management” as one of their top five business priorities over the next three years. Insurance companies aren’t the only ones struggling with hiring analytics talent: CareerCast.com ranked data scientist as the toughest job to fill in 2017. A recent study by IBM and Burning Glass Technologies projected that over the next five years the number of job postings would grow 28 percent. In part, the talent shortage is due to the heightened education requirements for data science positions, which often require advanced degrees, and the lack of an experienced workforce given the newness of the career. Both of these factors exacerbate the supply and demand imbalance by lengthening the training period for new workers.

Closing the talent gap
One way for companies to close this gap within their own organizations is to use software to automate the data science work flow. Called “automated machine learning,” these technologies can maximize the efficiency and productivity of the existing analytics staff by using software to automate repetitive tasks (see “Analytics Spotlight: Entrepreneurial perspectives on machine learning” on page 44). The goal is not to replace the data scientist but to “democratize” data science by empowering traditional analytics workers with less-advanced training to complete tasks they are currently unable to do. Research firm Gartner estimates that more than 40 percent of data science tasks will be automated by 2020, highlighting the magnitude of the opportunity for companies to reduce their need for advanced analytics talent.

Common repetitive tasks in the data science work flow that can at least be partially automated, include:

- **Exploratory data analysis:** Visualizing data before building models is an essential step in the machine learning process. Automated machine learning tools allow the user to easily graph each variable against the target variable—a task that is common across all projects.

- **Feature transformations:** This step involves applying transformations to input features (variables) as well as creating new features from the given input data. The goal is to create a set of features that accurately predicts the target variable. Many standard feature transformations can be applied to most problems, allowing for easy automation.

- **Model fitting:** The number of available machine learning algorithms continues to increase at a rapid pace. Automated machine learning platforms help the model builder determine the appropriate model fitting algorithm in an efficient manner. This assistance includes optimizing the input variables for each method, ensuring that the model fit is as accurate as possible.

- **Model diagnostics:** A similar set of outputs are used to evaluate the fit of most models to the target data. Automatically generating these standard outputs is straightforward and saves the analyst time.

- **Model deployment:** Automated machine learning platforms make it easier for data scientists to put their models into production by providing one-click deployment via application programming interfaces (APIs).
The way of the future

The changing landscape provides a significant opportunity for insurers to rethink their approach to underwriting. By determining where underwriters’ expertise and judgment can have the greatest impact, as well as how analytics can support this goal, insurers can chart a more productive, sustainable approach. Analytics and machine learning could reshape underwriting in several ways.

Pricing

As pricing entities seek to reduce their underwriting effort per dollar of premium, automated underwriting and other cost-effective methods of pricing risk will become more prominent in both personal and commercial lines. Homogeneous risks that can be modeled by predictive analytics will support product commoditization, enabling more efficient portfolio creation and improved access to capital through growing confidence in the accuracy of modeled outputs. Meanwhile, investments in big data and InsurTech are expected to catalyze technological enhancements and cost savings, fueling further competition among providers of the pricing function.

Despite the integration of analytics into pricing, underwriting expertise will continue to be valued. The inherent complexity and significant downside associated with certain risks—such as those with longer tails or clash potential—means that pricing capabilities remain valuable differentiators that cannot easily be replicated. High availability of capital will continue to create opportunities to provide pricing as a service to unsophisticated underwriting capital. The challenge will be to determine where pricing experts can be freed from low-value activities to generate the greatest value for insurers. Pricing experts will continue to play an important role in areas of greater complexity, while analytics has already made an impact on the more straightforward, transactional tasks.

Passive underwriting

For carriers positioned as follow markets, the path is less clear. Fundamental inefficiencies in subscription insurance markets will become exposed as insurance-linked securities (ILS) funds and capacity-rich reinsurers express a willingness to commit large blocks of “blind” follow capacity to leaders, funds, and facilities. The same trend—of detaching capital from the underlying risk—is witnessed in the proliferation of delegated authority agreements, reinsurance treaties, affinity schemes, underwriting facilities, and broker underwriting managers.

The modern Lloyd’s marketplace is a subtle example of this transformation from traditionally “active” to more “passive” underwriting. Roughly one-third of its premium is priced by delegated authorities; another third is reinsurance premium. This structure suggests that two-thirds of the market’s capabilities are today focused on aggregation. Passive underwriting, focused more on aggregation than pricing, should not be underestimated for its own complexity and value. The ability to optimize diverse, “live” portfolios in the face of partial correlation is a skill set with a relatively high barrier to entry. While this capability is traditionally focused within reinsurance companies, data, analytics, and technology will likely create opportunities for others to compete.

The benefits of analytics and automated machine learning are clear. Insurers and reinsurers that understand where to apply these technologies and how functions and roles must evolve will be well positioned to capture significant value in the coming years.
New enterprises in Asia and North America are developing Machine Learning Applications to bring new solutions to the insurance and risk sector. Aon sat down with Satadru Sengupta, the General Manager of the insurance practice at DataRobot in Boston, and Shonali Krishnaswamy, the CTO of AIDA Technologies in Singapore, to get their perspectives on the opportunities for new modeling approaches and predictive analytics.

Q What problems are insurance companies facing today in terms of predictive analytics?

Satadru Sengupta: Predictive analytics have been an important part of the industry for a long time. However, organizations are struggling to find the right strategy for sustainable use of machine learning to take advantage of the latest modeling techniques. At most organizations, there are not enough data scientists to do what needs to be done, and strategies on hiring additional data scientists or outsourcing are falling short. The DataRobot machine learning automation platform uses artificial intelligence (AI) to give the power of machine learning to any business user, risk analyst, or actuary.

Shonali Krishnaswamy: The need to deal with noisy data and to model at speed and at scale is the key problem for today’s modelers. Here is how I would characterize the challenge: Organizations need general machine learning components. We have 12 data scientists that have developed our own specialized components—repeatable “solutions” that tackle real world challenges in insurance and banking. We think the way to address the challenge for the industry is to apply very specific, sophisticated solutions in a tailored way.

Q What has changed in the discussions you are having with insurance executives around machine learning in recent years?

Satadru Sengupta: In the past couple of years, the changes have been exponential, largely because machine learning and artificial intelligence (AI) have become much more mainstream topics. What we are not hearing anymore is “we are not ready.” As a reaction to the market changing, insurance companies are competing to develop and deploy machine learning solutions and executives are choosing an automation strategy as that puts them on the fastest path to machine learning and AI competence.

Shonali Krishnaswamy: In our most recent discussions, there is more of a focus on how we can combine the power of machines and human experts—we use the term “augmented intelligence.” In other words, what had been a largely theoretical discussion in the past about self-learning and feedback mechanisms has become far more real. What has changed is that we have more examples in organizations with specific processes, such as in claims.

Q How do you see the future use of machine learning in organizations that depend on predictive modeling?

Satadru Sengupta: I think that many more industries will leverage machine learning—not just the industries that are very active in it today, like insurance. I anticipate adoption will be similar to how personal computers entered businesses. Initially, only computational heavy industries utilized them. Then, it was for only a few expert users, or power users, in all industries. Today, of course, we don’t even talk about PCs being leveraged by businesses. I think machine learning will be a part of most industries soon, and new solutions will mean that these models will be embedded in many processes within the organization. And most importantly, it will be used by a broader user group. For any business user, just like computer skills, machine learning is going to be a core capability.

Shonali Krishnaswamy: I believe that organizations that are able to adopt machine learning correctly will really have a strong competitive advantage. They will be able to predict and pre-empt rather than detect and react. They will be able to better engage customers, better manage risks and have more optimal and data driven processes. I actually do not believe that organizations can choose to not engage with this exciting paradigm. The question is more about organizations having an innovation mindset and being willing to experiment and adopt [machine learning] ... correctly!

Global Insurance Market Opportunities
Section 5

Perspectives
Global Insurance Market Opportunities

Re-Imagining Risk Management

Carriers should look at novel business models and emerging technologies as opportunity generators that can open the door to new risk markets.

We hear a lot about disruption, the new paradigm, and strategic pivots. Is it all hype? Let’s review the figures. InsurTech is one of the fastest growing entrepreneurial segments. In 2016, more than 200 InsurTech start-ups attracted USD 9 billion in investment. Today, there are more than 550 with nearly USD 14 billion in investment.

With all the gnashing of teeth about how InsurTech is going to hurt the industry, one would think some outside force was imposing its will on us—some Wall Street bankers or faceless global power brokers at work. Instead, it turns out that we are fueling the fire ourselves. We are enabling the disruption.

First, carriers are a source of capital. That’s happening because it allows incumbents to stay close to new ideas. Interestingly, for an industry perceived as boring or overly cautious, we have been active in this space. In 2016, corporate venture capital participation in InsurTech was two times higher than participation across all sectors. Second, industry players are investing in semi-autonomous innovation centers or labs. These spaces include a hybrid-type organization that focuses on analytics or generates innovative ideas in some way. Lastly, organizations are creating pilots or partnerships with start-ups and entrepreneurial ventures, developing consortia to set industry standards, and building relationships with universities.

But what are the broader trends to follow as we see technology impacting our sector?

Behavioral data
Many carriers are on a constant search for new proprietary data sources. These sources are meant as inputs to analytics so we can underwrite or price better. We are also on a constant search to better curate the data we have on our servers; in other words, to better use what we already know about our clients or own operations.

Technology can help in both quests. However, the real power of the new technology and business models will be to help our industry create fresh sources of data. Data generated by the Internet of Things (IoT) is a good example—wearables track activity levels, heart rate, and other metrics. But so is the old-fashioned bicycle. In China now, several start-ups have deployed tens of millions of bikes in cities across the country, usually dock free. A rider uses a smartphone to open one up and pays about 15 cents for a 30-minute ride. The two biggest operators are Ofo and Mobike. Each has valuations of more than USD 1 billion. Ofo has over 3 million bikes in operation, and Mobike has 5 million. Each day, both companies have more than 20 million rides each.

What is going on here? At 15 cents a ride—and sometimes entrepreneurs are not charging at all—there is little chance that fees will be the source of profit. Many observers suspect that a primary source of value will be data collection on consumer behavior and risk assessment. Alibaba, through its affiliate Ant Financial, is an Ofo investor. And Tencent is an investor in Mobike. Alibaba and Tencent are aggressively entering financial services—banking, credit, and even insurance. But China doesn’t have reliable credit scores such as in the United States. Now, players are triangulating to get to the equivalent of risk scores using social media and other online sources. The usage of these bikes on a daily basis is creating a new source of data. As an industry, we may have to think more expansively about data.

Temporal segmentation
We are living in an on-demand economy. Amazon is pursuing instant delivery. Entertainment is mobile and tailored to our tastes. Even with insurance, carriers compete on almost instantaneous applications and claims that are adjusted in minutes.

The biggest time-based innovation is the sharing, or on-demand, economy. Companies like AirBnB allow consumers access to huge inventories of properties—to rent something, even a room, for a slice of time. Ride-hailing services such as Uber or Lyft also allow car owners to subdivide how they can use their car by time.

PwC predicts that by 2025, the sharing of assets with digital platforms will be as large as the traditional rental economy (car rental, hotels, and equipment rental). This sharing opens up the need for insurance coverage that is
more “time based.” For example, the start-up Trov provides on-demand coverage for property. Another start-up, Slice, provides liability coverage by the minute. It is specifically tailored to address the needs of the sharing economy.

One major implication of the new technology will be a rethinking of how insurance products are designed. Reflect on how retailing (with same-day delivery) and transportation (with rent-by-the-minute) is evolving. Can traditional risk products serve these emerging consumer and commercial needs? The current insurance industry is well positioned to both identify gaps in coverage, such as those posed by passengers of ridesharing services, and leverage existing product knowledge to adapt and develop new products to fill such gaps. However, this advancement will take not one, but a system of innovations. For example, perhaps we will need to build more behavioral factors into our products to reduce moral hazard in these peer-to-peer technologies. Also, new IoT technologies may lend themselves to parametric instead of indemnity products.

**Virtual communities**

Corporate organizational structure is changing with technology. Corporations have long been at the center of activity. They designed, built, and delivered products, and grew in size and sophistication throughout the last century. Some banks, for example, are deemed too big to fail, while some multinationals seem as powerful as nation-states.

Nonetheless, digital networks or platforms today dwarf corporations and, in some cases, even countries (see exhibit below). Only three nations make the top 10 list of networks: China, India, and the United States. The chart shows a selection of organizations from the top 10 list. Each one of these digital platforms is a vehicle for commerce, communications, and partnerships.

They also generate new types of risks that need to be managed. Reputation risk is the top concern in the Aon 2017 Global Risk Management Survey—and it is a direct result of the influence of these social networks. Insurance products and services must be adapted for commercial life on these networks, not just to use them to distribute existing products. We will need to innovate to create solutions to economic actors that are interacting in a different way in this new “platform era.”

Given these exciting developments, it is no wonder that many insurance companies set up their own corporate VC funds, participate in accelerator programs, establish innovation labs, and form partnerships with the startup firms. Getting the right portfolio of innovation activites is critical; a disciplined approach with senior management guidance is required.

The trends noted above offer plenty of opportunities for the current industry to innovate. Technology is changing how consumers are exposed to risk. Insurers need to identify where gaps in existing coverages may exist and new risks are emerging in order to develop products that can respond, and so providing something of value that will drive premium growth.

### From corporations to platforms—total population or active users (billions)

<table>
<thead>
<tr>
<th></th>
<th>Total Population or Active Users (Billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facebook</td>
<td>2.00</td>
</tr>
<tr>
<td>WeChat</td>
<td>1.37</td>
</tr>
<tr>
<td>WhatsApp</td>
<td>1.20</td>
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<td>Alibaba.com</td>
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<tr>
<td>Visa</td>
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<tr>
<td>Twitter</td>
<td>0.33</td>
</tr>
<tr>
<td>Tencent</td>
<td>0.26</td>
</tr>
</tbody>
</table>

*Source: Company websites, Press releases*
Conclusion

This year’s Global Insurance Market Opportunities report has given us a broad view of the changing risk landscape, and demonstrates how there are numerous opportunities within our industry. But, in the long run, sustainable growth won’t be won by fighting for market share in existing or traditional markets.

It highlights how sustainable growth for participants will come, as it always has, by providing something of value that enables economic activity. The opportunity for our industry is that the fundamental drivers of such activity are being transformed by new technologies and new business models.

As we all try to navigate our way through this dynamic and increasingly challenging environment, an important part of the dialogue among senior leaders in organizations should include the following issues:

- “What key skills and capabilities are required?”
- “Do our innovation processes maximize our likelihood of success?”
- “What new technologies are going to impact us and our clients most?”
- And, perhaps most importantly, “how can we innovate how we innovate?”
Sources and Notes

Introduction
Sources:
The Third Wave: An Entrepreneur’s Vision of the Future, Steve Case, April 2016

Section 2: Risk
Moving Towards Cyber Resilience, Page 8
Sources:

Pathogen Risk Touches Multiple Sectors, Page 10
URLs:

What’s Ahead for Commercial Auto Insurance?, Page 14
Sources:

Rise of the On-Demand Economy, Page 20
URLs:
http://time.com/4169532/sharing-economy-poll/

Inside the Data, "Impact of Weather Events on the Economy", Page 22
Sources:
Aon Benfield and World Bank GDP

Section 3: Capital
The Capital Efficiency Gap, Page 24
URLs:

Risk-Adjusted Underwriting Returns, Page 27
Notes:
The CAPM is used to establish an appropriate required rate of return of an asset in order to make decisions about adding assets to a portfolio.

InsurTech Start-Ups are Making Waves, Page 31
URLs:
http://www.huffingtonpost.com/parker-beauchamp/insurance-industry-tips-t_b_9458594.html
Section 4: Data & Analytics

Inside the Data, "Cyber Risk Aggregation", Page 34
Sources:
Analysis by Aon Benfield using Cyence

The Neglected Risk: Recent Developments in Casualty Catastrophe Modeling, Page 36
URLs:
http://www.ambest.com/ratings/PC_SRQ.PDF
https://www.praedicat.com/technology/

Evolving Cyber Risk Modeling Methods, Page 39
URLs:

Notes:
Cyber CV calculated using Cyence model on a representative Fortune 500 portfolio of companies. Other CVs from the study’s companion volume: Global Risk, Profitability, and Growth Metrics, 2017 edition

Analytics and the Underwriting Transformation, Page 42
URLs:
http://www.gartner.com/newsroom/id/3570917

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URLs:
Contacts

For more information on the Global Insurance Market Opportunities study or our analytic capabilities, please contact your local Aon broker or:

**Paul Mang**
Global Chief Executive Officer of Analytics  
+65 6812 6193  
paul.mang@aon.com

**Tracy Hatlestad**
Global Chief Operating Officer of Analytics  
+65 6512 0244  
tracy.hatlestad@aon.com

**Greg Heerde**
Head of Analytics & Inpoint, Americas  
+1 312 381 5364  
greg.heerde@aon.com

**George Attard**
Head of Analytics, International  
+65 6239 8739  
george.attard@aon.com

**John Moore**
Chairman of International Analytics  
+44 (0)20 7522 3973  
john.moore@aon.com

**Kelly Superczynski**
Head of Analytics, EMEA  
+1 312 381 5351  
kelly.superczynski@aon.com

**Dan Dick**
Global Head of Catastrophe Management  
+1 214 989 2167  
dan.dick@aon.com
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