Who Knew?

Black swan events can't be predicted, and often can't even be imagined, yet insurers still must cope with them.

by Jayanta Guin

After two quiet decades of tropical cyclone activity in the United States, Hurricane Andrew—considered a black swan of its time—catapulted the catastrophe modeling industry into prominence.

Since then, each successive large and unexpected catastrophe has prompted a re-examination of existing risk management practices. Traditional statistical tools are not able to capture either the frequency or severity of black swan events, so how should companies prepare for their impact?

Illustration by Angel M. Negrón

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The term "black swan" was used in Europe until the late 17th century as a metaphor for something that does not exist, as all swans observed until then had been white. After an explorer traveling to Australia in 1697 noted the existence of black swans there, the term evolved to mean a seemingly impossible occurrence, but one that cannot be falsified by evidence to the contrary. In other words, no number of white swans observed can refute the possibility that black swans exist.

The concept was re-popularized by Nassim Taleb's 2007 book, *The Black Swan*, which holds that the course of human history is largely shaped by unforeseen events, both positive and negative, whose probabilities are underestimated because they are too difficult to comprehend.

Taleb, who is credited with predicting the 2008 financial crisis, described severe flaws in the risk management practices of banking and trading institutions that exposed them to calamitous losses not contemplated in the mathematical models on which they relied.

Key Points

- **The Situation:** Black swan events, although catastrophic, cannot be given a definite probability of occurring by cat modeling technology.
- **The Back Story:** When black swan events occur, they are often triggered by events such as hurricanes or earthquakes.
- **The Bottom Line:** Cat models can incorporate historic event data to develop potential risk scenarios for the most extreme events.

In the realm of risk management, adverse events can be classified as known-knowns, known-unknowns or unknown-unknowns. Catastrophes considered known-knowns are events for which there is abundant data and historical precedence, and they can typically be accounted for using past experience.

Known-unknown events are rarer and have more severe impacts; it is to prepare for these that companies employ catastrophe models. While there is inherent uncertainty associated with known-unknowns, a robust model uses what has occurred in the past to infer what is possible in the future. For example, though it is not known when or exactly where the next inevitable big earthquake will strike in California, catastrophe models can account for the probabilities associated with a full spectrum of loss outcomes.

For even higher-impact events, knowledge deteriorates precipitously with decreasing probability of occurrence. Black swan events belong to this last category of unknown-unknowns; their probability and severity are not possible to estimate with any degree of accuracy. While black swan events are a subset of rare or "fat tail" events, not all fat tail events can be considered black swans. Black swans are often unimaginable until they actually occur, and as such cannot be considered in a probabilistic sense in a catastrophe model. They are unique in that there is no "typical case."

Unlike distributions such as life expectancy and height, there can be extreme outliers for catastrophe losses, which can be 10, 20 or even 100 times the average value. Losses can scale dramatically beyond any historical experience. A trillion-dollar economic loss (7% of U.S. gross domestic product) could be realized, for example, if a Category 5 hurricane were to strike the densely populated Northeast, even though no such loss has ever been experienced. For that matter, most scientists do not even consider such an event to be physically plausible.

Black Swans in Natural Cats

Black swan events are unexpected either from an intensity perspective—they are not thought to be physically plausible—or a loss perspective—the damage inflicted was not thought possible, even if the physical event itself had been contemplated. Knowledge of the underlying physical processes at work will always remain imperfect, so there is significant uncertainty as to what is truly a "tail" scenario. For example, there is significant uncertainty about the physical processes surrounding climate change. How it will affect the occurrence of hurricanes, severe thunderstorms and other hazards represents an even higher order of uncertainty. Climate change can—and undoubtedly will—surprise us in many ways.

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Interactions between different physical processes (each of which, individually, may be unexceptional) can also lead to unexpected results. Hurricane Katrina, for example, triggered the catastrophic failure of the levee system in New Orleans. The Christchurch, New Zealand, earthquakes of 2010 and 2011 caused unexpectedly severe soil liquefaction. Another example is the 1923 Great Kanto earthquake, the deadliest in Japan's history; the earthquake struck almost concurrently with a typhoon, which fanned the fires spawned by the earthquake into vast conflagrations.

In terms of losses, direct damage to physical assets is constrained by the value of the assets themselves, but the indirect effects can be nearly limitless. Often, the exposure for business interruption coverage, particularly contingent BI, is not well understood by the insurer or the insured, and losses can result from various feedback loops. The 2011 floods in Thailand, for example, caused an estimated $15 billion in insured losses, a tally that may continue to rise. The automobile and hard disk industries were particularly hard hit as manufacturing output came to a standstill at hundreds of inundated, inaccessible or powerless factories, revealing the extreme vulnerability of global supply chains to natural disasters.

Particular political and regulatory environments can inflate losses. For example, while asbestos had been documented since the 1920s to be harmful, a period of widespread litigation during a regulatory regime friendly to the public in the 1980s and 1990s resulted in extensive losses to the insurance industry.

Cats: A Matter of Perspective

Was 2005's Hurricane Katrina a black swan event? The number of fatalities it caused was a surprise to most people, but the economic losses were within expectations for a major hurricane.

What about the magnitude 9 Tohoku earthquake in March, 2011? Again, the level of insured loss falls well within the range to which prudent executives manage risk (with an estimated return period of 40 to 80 years), even if the actual rupture and subsequent tsunami caught most seismologists by surprise.

When thinking about black swan events, it is important to note that perspective matters. What may be a black swan to society at large may have limited insurance impact. Likewise, some events that cause catastrophic losses may not seem extreme from all perspectives.

Economic and social factors are also sometimes at play. A long lull in hurricane activity during 1970s and 1980s led to complacency in disaster preparedness. This resulted in less-stringent building standards and a relaxed attitude towards building maintenance that coincided with a construction boom, all of which contributed to the high losses caused by Hurricane Hugo in 1989 and Hurricane Andrew in 1992.

Finally, it should be noted that the misuse of risk management models can lead to black swan events. Decisions based on incorrect data and faulty assumptions can lead to ineffective risk management practices or a false sense of security, setting the stage for events like the 2008 financial crisis. Further, incorrect or misguided interpretation of model results—for example, focusing on one particular loss metric or ignoring the tail of a loss distribution—can leave companies ill prepared for plausible loss scenarios.

Meanings for Cat Models

Probabilistic catastrophe models use statistics from historical data augmented using various resources, including scientific and engineering expertise coupled with physical models, to provide a wide range of potential scenarios of what might be experienced in the future.

By virtue of their being probabilistic, black swan events present a particular challenge because they cannot be assigned a probability with any degree of confidence. The hypothetical Category 5 hurricane hitting the Northeast is an extremely unlikely, but not entirely unimaginable, scenario; should it be assigned a probability of 0.0001% or 0.00001%? No one can say.

To help gauge the impact of black swan events, catastrophe modeling companies can develop sets of physically possible extreme-loss scenarios that can be considered deterministically within modeling software platforms. While it is not possible to create an exhaustive set of black swan events, and indeed the scenarios likely will fall closer to the known-unknown category than they will to the truly unknown-unknowns, they will nevertheless be ones that stochastic modeling techniques are unlikely to capture. Risk managers can use these deterministic scenarios to perform a critical analysis of the peril and exposure to inform loss mitigation strategies.

Modeling companies should also explore other ways to address currently unmodeled sources of loss that can contribute to black swan situations. This includes secondary perils that may not yet be modeled—for example, the tsunami and landslides that can accompany earthquakes—and currently unmodeled asset classes within existing models—for example, losses to insured infrastructure.

Furthermore, there is a need to better capture indirect and secondary losses, which can far exceed damage to physical assets. Contingent business interruption losses, for example, involve complex feedback loops with ramifications that extend far beyond the geographic scope of where the event occurred.

Other sources of unexpected increases in losses include loss inflation as a result of political pressure or the simultaneous occurrence of two hazards, such as an earthquake causing a dam failure that leads to significant flooding.

It is important to remember that knowledge is imperfect and constantly evolving. No matter how sophisticated and detailed catastrophe models become, they will never encompass the entire realm of what is possible; ultimately, the hazard is unpredictable.

While catastrophe models have become essential tools in sound risk management, it is prudent to be aware of their limitations and to be resilient to imperfect models. BR

Causes of Black Swans

1) Unexpected interactions between physical phenomena.
2) Indirect and secondary losses.
3) Political and regulatory environments.
4) Social and economic factors.
5) Misuse and misinterpretation of risk models.

Source: AIR Worldwide