

Pandemic and Alien Invasion

Not on Your Radar?

Extreme Risks Matter

By Tim Hodgson, Stephen Lowe and Liang Yin

If you think extreme risks are too remote to worry about, just consider what the Yucatan asteroid did to the dinosaurs. We explain why extreme risks matter.

Recently, Towers Watson updated its list of extreme risks to the world's economic, social and political stability. These risks, while unlikely to occur, would have significant implications for insurers and, more globally, nations and world financial markets and infrastructures.

The potential for major disruption to world economies and daily life was intriguing enough to prompt a Towers Watson team to begin studying extreme risks in 2008. We published our first list of extreme risks in 2009 and updated the list in 2011 and 2013. Further reflection motivated us to expand our list from 15 to 30 extreme risks to accommodate risks that can't be classified as financial or economic. We are also prioritizing risks differently.

What Are Extreme Risks?

Extreme risks are potential events that are very unlikely to occur but would have a significant impact on the global economy, existing social orders or current political regimes. Historical examples include the formation of OPEC and the oil embargo, which altered the structure of the global energy market and fostered a global wave of inflation; two world wars, each of which fundamentally altered the world political order; and the arrival of Europeans (with smallpox) in North America, killing off an estimated 90% of the Native Americans in New England. For the dinosaurs, the list would include the Yucatan asteroid and the ensuing conditions that caused their extinction.

Extreme risks are not the same as emerging risks. They are generally ever present, although our awareness of them, and their likelihood, may be heightened by current events. And generally, extreme risks are at the far tail of spectral risks, a

risk measure weighted more toward bad outcomes. For example, minor asteroids strike the earth with relative frequency, sometimes even causing quite severe but localized damage. The extreme risk in this case is a monstrous asteroid that would cause devastation on a global scale.

Why Care?

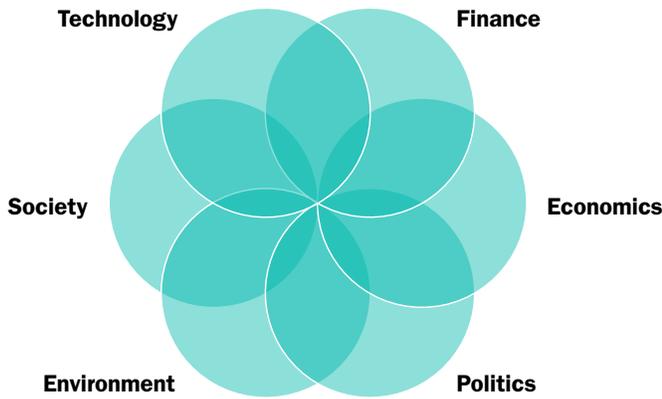
The recent global financial crisis, while perhaps not reaching the same level of significance as the above examples, has shown us that risk management must consider low-likelihood but potentially high-impact events. A robust risk management approach will not focus solely on a particular percentile of risk distributions developed from historical patterns of behavior. To be robust, the approach must look out into the tail to consider extreme risk events that may be highly unlikely but would have a profound impact.

Increasingly, we view the world as a series of interrelated, complex adaptive systems, covering markets, political regimes and other social structures. These systems reflect the collective behaviors of the participants (mostly human behaviors, especially fear and overconfidence), and are susceptible to sudden and violent regime change when tipping-point events occur. This can be especially true when participants in an event react and adapt reflexively to it, often in a manner that tends to reinforce rather than mitigate its impact. And the complexity of these systems has been increasing with new technology, expanded regulations and globalization. Extreme events often anticipate significant evolution of these systems, where the regime changes taking place will often render historical event probability distributions irrelevant. A more detailed examination of how

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Figure 1. How we see the world



extreme events change these systems is available in our extreme risk white paper (<https://cas.confex.com/cas/ica14/webprogram/Session6958.html>). Extreme risks are also more relevant to long-term financial security plans, such as defined benefit pensions, long-term disability plans, life insurance, annuities and casualty insurance, for which claim settlements stretch over long time periods. This relevance was captured quite eloquently by Lloyd Blankfein, CEO of Goldman Sachs, when he pointed out that “most risk management is really just advanced contingency planning and disciplining yourself to realize that, given enough time, very low-probability events not only can happen, but they absolutely will happen. The definition of infinity is that if you wait long enough, everything happens.” Beneficiaries of these long-term security plans face risk serially, compounded over the duration of their participation in the plan. To keep the promises inherent in these plans, their managers need to be concerned with extreme risks.

Our inventory of extreme risks can serve as a pump-priming starting point for risk managers, who will need to consider the relevance of each extreme risk to their business and develop a response plan for those risks with sufficient relevance.

Current List of Extreme Risks

In the risk identification phase of our latest review, we classify extreme risks in six broad categories that house our 30 extreme risks (Figure 1).

Extreme financial risks capture an inability to meet financial liabilities on a massive scale, leading to a collapse of the financial system. This could occur as a liquidity issue, such as a banking crisis, when institutions have insufficient liquid assets to meet their current demands for payment, even if the institutions have more assets than liabilities. Alternatively, the financial crisis could be driven by insolvency, such as an insurance crisis or a sovereign default, when assets are insufficient to meet liabilities.

Extreme financial risks include:

- **Banking crisis (F1).** Central banks are unable or unwilling to supply sufficient liquidity to institutions. Failure to make payments cascades rapidly through the financial system, causing banking and eventually real economic activity to stop.
- **Insurance crisis (F2).** Catastrophic events cause failures at major insurers, leading to withdrawal from markets by others. The failures create adverse wealth effects for beneficiaries, and/or the lack of availability disrupts commerce.
- **Sovereign default (F3).** Nonpayment by a major sovereign borrower causes market panic and disrupts the global economy in a major way. Failure to make payments could cascade rapidly through the financial system, especially if there is a loss of trust within the system.

Extreme economic risks occur when there is some form of major shock to the economic system: a shock to growth, a shock to price levels or a collapse in trust that is essential to the working of the economic system. Generally, these shocks stem from some form of fundamental imbalance in the economy that reaches a tipping point. Growth shocks can take the form of a depression or stagnation. Price level shocks can occur in opposite directions: rapid prices in hyperinflation or falling prices in deflation. In both cases, the “incorrect” price signals cause serious economic damage and destruction of wealth. A collapse in trust could

occur in the current monetary system, leading to the abandonment of fiat money; in the value of a major currency, creating a currency crisis; or in the economic system as a whole, leading to the breakdown of capitalism.

Seven extreme economic risks are worthy of attention:

- **Abandonment of fiat money (E1).** A collapse in confidence in the purchasing power of paper currency and the consequent return to a gold standard
- **Breakdown of capitalism (E2).** Distrust in the private capital/property system, causing a collapse in economic activity and asset prices
- **Currency crisis (E3).** A significant devaluation of a major currency that becomes self-fulfilling, with loss of purchasing power
- **Deflation (E4).** Goods and services prices fall for a long period, transferring wealth from borrowers to savers; often associated with a depression
- **Depression (E5).** A rapid and painful contraction in economic activity leading to a deep trough in economic output, massive increases in unemployment, restriction of credit and shrinking investments
- **Hyperinflation (E6).** Prices increase rapidly, wiping out savings, provoking extreme consumption and hoarding of real assets
- **Stagnation (E7).** A prolonged period of little or no economic growth, usually accompanied by high unemployment and growing political dissatisfaction

Extreme political risks are derived from policy decisions that turn out to be poor choices. In some cases, the policy decisions may be quite direct, while in others, they may be more subtle. However, in all cases, poor prior policy decisions are a necessary, if not sufficient, condition for these risks to eventuate.

Extreme political risks encompass:

- **Anarchy (P1).** Income inequality, supported by modern communication, fosters extreme social disorder in a major state, leading to government and economic collapse
- **Global trade collapse (P2).** A protectionist backlash against cross-border mobility of labor, goods and capital, causing global trade to collapse

- **Political extremism (P3).** The rise to power of an oppressive government in a major economy, leading to mass murders and a threat to global peace
- **Terrorism (P4).** A major ideologically driven attack on an important target, inflicting large-scale human and financial damage that is even more devastating than 9/11
- **World War III (P5).** A war among many of the world's major countries, killing millions, and destroying physical and human capital

Extreme environmental risks are threats to human safety and well-being arising from a disruption to planet Earth's environment. Two of these risks (alien invasion and cosmic threats) are exogenous to Earth and largely beyond our control. Two others of these risks (biodiversity collapse and global temperature change) could be caused by humans and are perhaps within our control. In considering our list of environmental risks, one could easily question the seriousness of including alien invasion. We would respond to this question by suggesting that risk management is planning in advance the actions one would take in response to events, and the value of the exercise is in scanning the horizon with the broadest possible mind. At the assessment stage, it is likely that many organizations might have filters that would work to drop alien invasion from further consideration.

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Five kinds of extreme environmental risks exist:

- **Alien invasion (e1).** An invasion by non-peace-seeking aliens that seek to remove the planet's resources or enslave/exterminate human life
- **Biodiversity collapse (e2).** Destruction of the world's ecosystem, leading to problems with human food and water supplies, disease or climate issues
- **Cosmic threats (e3).** Planetary risks such as the impact of a large meteorite, giant solar flare or magnetic storm
- **Global temperature change (e4).** Earth's climate tips into a less habitable state (hot or cold), disrupting social and economic systems
- **Natural catastrophe (e5).** A confluence of major earthquakes, tsunamis, hurricanes, floods or volcanic eruptions with major global effects

Extreme societal risks are threats that could adversely affect the smooth functioning of society. It should be noted that the risks in our categorization are not independent, and it should be clear that societal risks also link to policy decisions, the environment and, in some cases, technology. For instance, a food/water/energy crisis will have political, environmental and technological drivers as well as offsets. Three of the risks are health-related, representing different extremes.

Five varieties of extreme societal risks exist:

- **Extreme longevity (S1).** Advances in medicine or genome science significantly increase life expectancy, overwhelming support systems and stressing intergenerational politics (for more information on this topic, see “Are Impressive Longevity Improvements Softening?” on page 15 of this issue)
- **Food/water/energy crisis (S2).** A major shortfall in the supply of or access to some combination of food, water or energy, causing severe societal issues
- **Health progress backfire (S3).** Massive rise in morbidity or mental illness, perhaps due to an unintended consequence of a new health practice

- **Organized crime (S4).** A significant increase in the scale of illegal operations in a major economy, threatening the viability of legitimate economic activity
- **Pandemic (S5).** A new, highly infectious and often fatal disease spreads through human, animal or plant populations worldwide

Extreme technological risks are those that arise from our increasing reliance on technology to achieve greater efficiency in production and global communication. The risks range from a failure in current technology (nuclear contamination, infrastructure failure), to the possible consequences of emerging technology (cyber-warfare, biotech catastrophe) and the unknowable future event of the technological singularity.

Extreme technological risks include:

- **Biotech catastrophe (T1).** Biological technology (genome, nanotechnology, among others) is applied in a destructive way, either intentionally or inadvertently; overlaps somewhat with S3 (health progress backfire)
- **Cyber-warfare (T2).** Computer sabotage/espionage on a major scale, with severe damage to infrastructure, financial, medical or defense systems; possibly acting as a precipitant to economic or financial risks
- **Infrastructure failure (T3).** An interruption of a major infrastructure network, disrupting economies or impacting basic needs (e.g., loss of the electricity grid for an extended period, particularly during the winter)
- **Nuclear contamination (T4).** A major nuclear event or large radioactivity release, leading to lethal effects on individuals
- **Technological singularity (T5).** Technological advancement proceeding beyond the point of human understanding or control, threatening human life; “singularity” refers to the point where computers achieve intelligence beyond that of humans

Risk Assessment

Once identified, we assessed our 30 extreme risks by *likelihood*, *impact* and *uncertainty*. Our assessments were not specific to any particular industry or geography. In the next section, we show some alternative risk assessments that are specific to the insurance industry. In reviewing our assessments, keep in mind that for each event, we are considering the worst-case scenario, rather than more commonplace manifestations along each event spectrum.

We assessed the likelihood of each risk using a four-point scale ranging from “once every 10 years” to “once every 100+ years.” Any probabilities attached to the scale are highly subjective, as there is no scientific way to measure the likelihood of these extreme events. However, a rough gauge of the relative likelihood of each type of event is still useful.

Impact was assessed by *intensity* and *scope*. An event’s intensity was labeled “endurable,” “crushing” or “existential.” For an individual, the three states are roughly comparable to a broken leg,

paralysis and death. Intensity assignments reflect what we can learn about these types of events given their rarity and are also quite subjective.

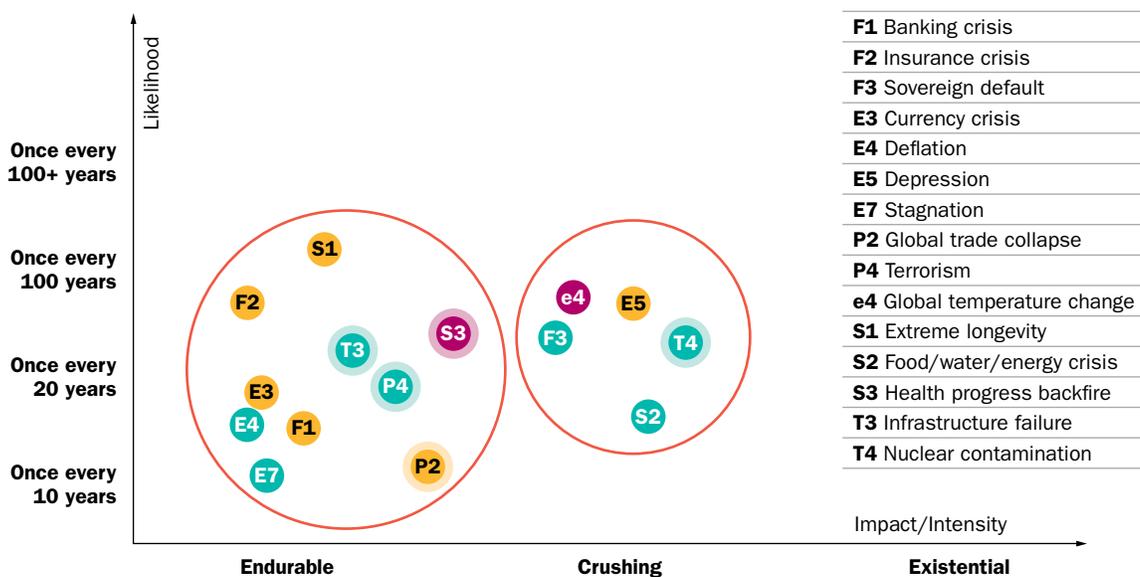
The spatial and temporal aspects of scope were labeled with temporary identifiers — “local” or “global” — or lasting identifiers — “transgenerational” (a few generations) and “pangenerational” (all subsequent generations).

Finally, we assigned an uncertainty score to each risk associated with likelihood and impact.

The results of our assessments for the 15 risks we identified as most important (*Figure 2*) use a filtering methodology described in the next section. For example, in this filtering process, alien invasion was culled out. In *Figure 2*, likelihood and intensity are represented by the two respective axes; scope is represented by the color of the dot, and uncertainty is represented by the fuzziness of the dot. There is a general upward slope toward the top right, implying that the worst risks are also the least likely. Exceptions are S1 (extreme longevity) and F2 (insurance crisis), which are assessed to have both very low likelihood and low impact.

“Our assessment and ranking reflect both our opinions, based on our research into the subjects, and our efforts to reach out to the insurance industry to get an external, industry-specific ranking of the extreme risks.”

Figure 2. The top 15 extreme risks



Scope of the impact
 ● Local ● Global ● Transgenerational ● Pangenerational

The size of the dot is indicative of the level of uncertainty regarding the likelihood/impact of each risk.

“Extreme risks matter, and they deserve more attention than they have been given.”

We split the risks in Figure 2 into two groups:

- **Five risks with crushing intensity of impact.**
The effect on invested assets are expected to be global and materially negative — bad news both in general and for insurers. While the value of liabilities might also fall, the impact is uncertain and would likely depend on local circumstance.
- **10 risks of enduring intensity.** Their impacts are less homogeneous, both in general and on insurers. For instance, a reversal of health improvements would reduce pension liabilities, but probably increase health and disability insurance liabilities. Extreme longevity would explicitly increase pension and life insurance liabilities.

Figure 3. Extreme risk ranking as of June 30, 2013 — Top 15 risks*

Rank	Risk	Description
1	Food/water/energy crisis	A major shortfall in the supply of food/water/energy
2	Stagnation	A prolonged period of little or no economic growth
3	Global temperature change	Earth's climate tips into a less habitable state (hot or cold)
4	Depression	A deep trough in economic output with a massive increase in unemployment
5	Global trade collapse	A worldwide protectionist backlash against cross-border trade
6	Banking crisis	Banking activity halts due to lack of liquidity
7	Sovereign default	Nonpayment by a major sovereign borrower
8	Currency crisis	Extreme movement between floating rates
9	Deflation	Goods and services prices fall for an extended period
10	Health progress backfire	Massive rise in morbidity or mental illness; antibiotic resistance
11	Nuclear contamination	A major nuclear disaster leading to large radioactivity release and lethal effects
12	Extreme longevity	Significant increase in life expectancy overwhelms support systems
13	Insurance crisis	Insolvency within the insurance sector
14	Terrorism	A major ideologically driven attack
15	Infrastructure failure	An interruption of a major infrastructure network

*Our subjective measure is based on the intensity and scope of the impact, and the likelihood and degree of uncertainty in assessing the risk level.

Ranking the Risks

Finally, we ranked the 30 risks by their importance. This was done in two ways. First, we created a ranking that was not industry-specific by combining the four assessment scores into a single ranking. The intuition is straightforward: The more likely a risk, the higher the ranking. Likewise, the greater the intensity of impact and the larger the scope of impact, the higher the ranking should be. Finally, we concluded that the higher the uncertainty about the risk, the lower the ranking should be. The rationale is that it is hard to develop any sort of concrete mitigation plan for risks that are highly uncertain. Our ranking of the risks is shown in Figure 3.

At the top of our ranking is S2 (food/water/energy crisis). This risk earns top billing because it is one of the most likely risks, with likelihood and impact displaying little uncertainty. The consequences, while locally crushing, are not particularly severe relative to the other extreme risks and don't drive our weighting plan.

The power of the ranking system is that it consistently combines and trades off the four scores. Different weights could be applied if different trade-offs are needed. The point of the exercise, however, is to get to an unbiased prioritization of the risks for developing management actions.

Our assessment and ranking reflect both our opinions, based on our research into the subjects, and our efforts to reach out to the insurance industry to get an external, industry-specific ranking of the extreme risks. In the summer of 2013, we launched a “wiki survey” (one that poses questions in a simple, less constrained form than traditional surveys) and asked insurance risk management professionals to rank 29 of the 30 risks. We excluded F2 (insurance crisis), as it would be self-evidently the top priority for the insurance industry. We received over 30,000 votes from 565 unique Internet server addresses (roughly a measure of the number of companies responding, with multiple people often responding from the same company). Responses came from all over the globe.

We then compared our general ranking of the risks to the results of the global insurance wiki survey, focusing on the eight risks with the greatest disparity in ranking. We expected some differences, as the wiki-survey ranking reflects the importance of the events to the insurance industry, rather than society at large. This is the case, for example, with P2 (global trade collapse) and E4 (deflation), which we ranked highly but insurance professionals ranked rather low. Survey participants may believe that these events would have a lesser impact on the insurance industry than on other sectors of the economy (or they may have assessed the likelihood or level of uncertainty differently), with other risks being of higher priority.

While many of the differences in ranking make sense, a few stand out as surprising. We ranked e4 (global temperature change) highly, as our number three priority, believing that, at the extreme, it has the potential to be globally crushing with a transgenerational impact. In contrast, it ranked 18 among insurance industry survey participants. We simply don't agree with this result and expect that it stems from a misinterpretation of the event.

Conversely, survey participants ranked e5 (natural catastrophe) highly, as their number two priority for the insurance industry. In contrast, we prioritized it at 26. We suspect that industry executives were influenced by recent and more familiar natural events, and ones with a more immediately obvious impact on the insurance industry. Our definition of an extreme natural catastrophe was one that was much deeper in the tail of risk, such as a supervolcano (a user-submitted idea that was ranked only 53rd out of 57 risks by the participants). Our low ranking reflects our belief that there is no way to meaningfully plan for this type of event. We would certainly agree that planning for more modest events is critical to the insurance industry.

The Value of Our Exercise

Extreme risks matter, and they deserve more attention than they have been given. The range of potential consequences of these identified risks is very wide. Locally endurable risks would be uncomfortable for institutions caught in the wrong locale or with the wrong exposures, and would likely be enough to cause weaker ones to become incapable of completing their mission.

At the other end of the spectrum, globally crushing risks represent a systemic and potentially terminal outcome. The value of this exercise, however, lies outside prediction. To navigate through this complex world, we suggest insurance professionals and investors need to be open-minded, avoid concentrated risks, be sensitive to early warning signs, constantly adapt and always prepare for the worst.

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