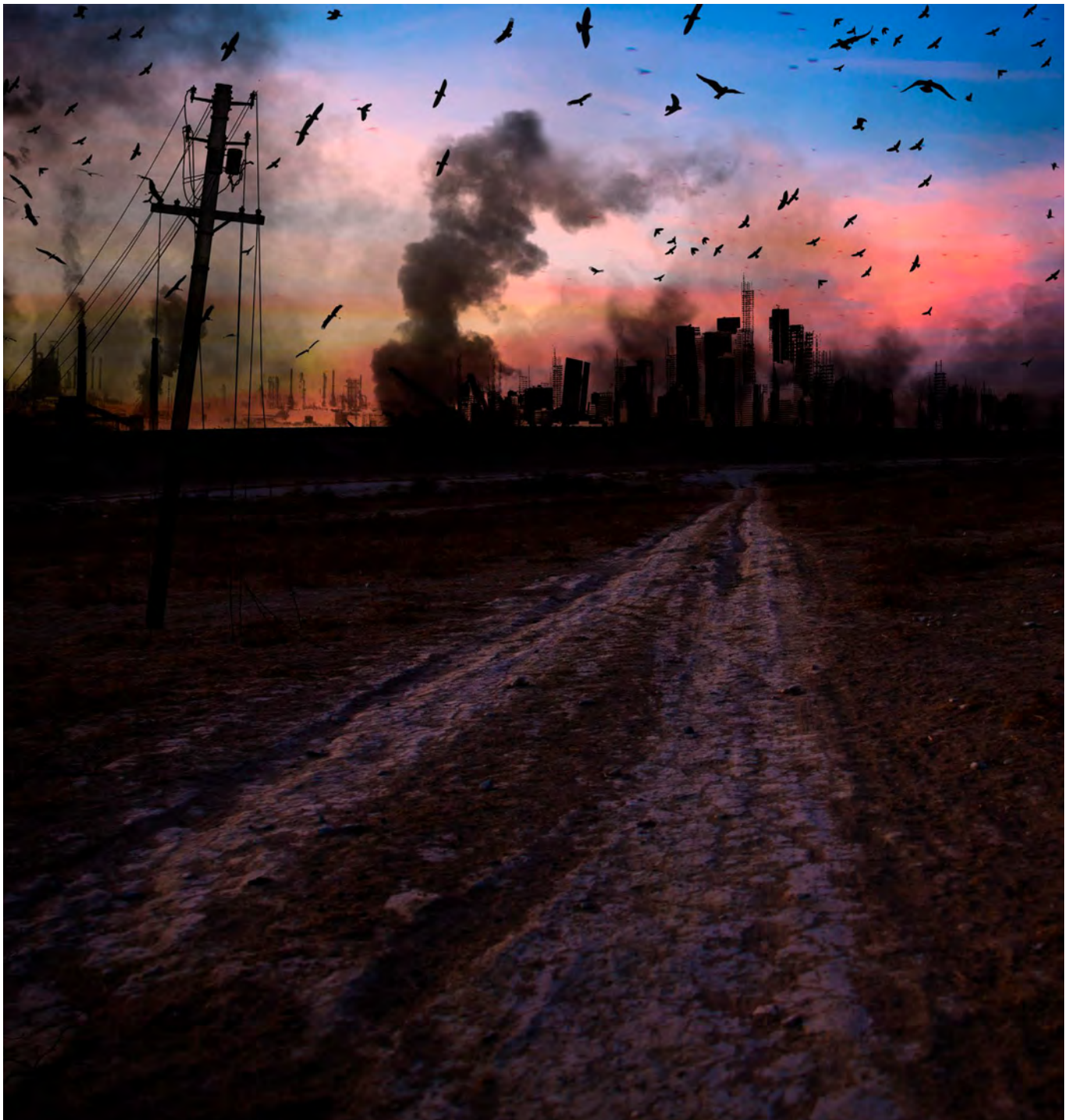


Thinking Ahead Institute

Extreme risks 2019







Contents

Introduction.....	2
The long list of 30 risks	5
Assessment framework	6
The top 15 risks.....	9
Hedging and investment implications	13
Appendix	15
About the Thinking Ahead Institute.....	47

Introduction

In short

Extreme risks are potential events that are very unlikely to occur (therefore infrequent) but that could have a significant impact on economic growth and asset returns should they happen. **Global temperature change, global trade collapse and cyber warfare** are the top three extreme risks identified in this paper. The value of this exercise, however, lies outside prediction. To navigate through this complex world, we suggest investors need to be open-minded, avoid concentrated risks, be sensitive to early warning signs, constantly adapt and always prepare for the worst.

Why do extreme risks matter?

“Most risk management is really just advanced contingency planning and disciplining yourself to realise 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.”

Lloyd Blankfein, Goldman Sachs then-CEO, July 2013¹

¹“Goldman CEO on risk: The worst ‘absolutely will happen’” CNBA.com. 2013

² More on this you can read Thinking Ahead Institute’s paper on [stronger investment theory](#).

³ Belief in reincarnation does not change the logic of our argument.

⁴ “The irreversibility of time – or why you should not listen to financial economists”, Thinking Ahead Group, Willis Towers Watson, 2012

⁵ “Existential risk prevention as global priority” Global Policy, Nick Bostrom, University of Oxford, 2013

This quotation highlights one of the important reasons for considering extreme risks. In addition, we have come up with a few others:

- We believe that the world is a complex adaptive system² where sudden and violent regime change is possible. In this description of the world, the tails of the “complexity distribution” are considerably fatter than those of a normal distribution. That means extreme events are much more likely than we previously thought
- We all only live once³, in a single universe, and we face problems in series, not parallel. This seemingly naive statement, as we argued in a previous paper⁴, is in fact often overlooked in the area of finance and economics when thinking about the “average”. This type of thinking has a profound impact on how an extreme risk event should be considered. The very unlucky person who was hit by a lightning strike does not take any comfort from knowing that this is extremely unlikely to happen to anyone. When confronted with an extreme event, there is no going back in time and “diluting” the impact with other less negative outcomes in parallel universes. One must deal with its consequences
- Last but not least, is that when it comes to assessing risks, particularly low-probability, high-impact events, our limited understanding of the world can have a material impact. In fact the uncertainty and our proneness to error can dominate when the extreme events involve poorly understood natural phenomena, complex social dynamics such as financial markets, or new technology⁵. For example, suppose that our body of knowledge indicates that some catastrophic event X has an extremely low probability $\Pr(X)$ of occurring. The margin of error associated with this estimate, resulting from flaws in our body of knowledge, could be significant. If this seems a strange concept at first, consider that our body of knowledge once thought the solar system was geocentric. In fact the whole history of scientific progress is one of correcting flaws in the previous body of knowledge. Extreme events might be much less extreme than we thought.

Extreme risks paper series

Our journey of thinking about extreme risks started in 2009. Our first paper in this area introduced a rather simplistic two-dimensional framework – likelihood and impact – to assess 15 risks in three categories – financial, economic and others including environmental and political themes. A ranking of these 15 risks was produced based on our subjective assessment of these two dimensions. The top three extreme risks that occupied our minds were economic depression, hyperinflation and excess leverage.

In 2011 we updated our likelihood and impact assessment of the previous 15 risk events. That resulted in two risks – resource scarcity and infrastructure failure – joining the top 15 ranking (at the expense of excessive leverage and the end of capitalism). Economic depression and hyperinflation continued to concern us and sovereign default (by a major developed economy) also became one of the top three risks.

Then two years later in 2013 a major update was conducted. We broke our “other” group into four categories: political, environmental, social and technological. As a result, the total number of extreme risks covered increased to 30. Perhaps more importantly, we addressed some of the weaknesses in the assessment framework. We introduced a new dimension: uncertainty. This is an important modification of the methodology. Assessment of the likelihood of any extreme risks is hard because they happen very infrequently, if at all, and therefore leave very little evidence for us to study and understand them. So we may assess a banking crisis and a global pandemic to have the same likelihood (say one-in-20 years events), but are they equivalent risks? We use uncertainty to differentiate between them. We believe the set of banking crises is more homogenous (low uncertainty), while a global pandemic event could take a wide range of forms (high uncertainty).

Why is this important? It helps the risk management function with time and resource allocation decisions. We would argue that time and resources are better spent on turning “unknowns” into “knowns” while steering away from “unknowables”, a trait associated with highly uncertain extreme risks. Our top three risks in 2013 were **food/water/energy crisis, stagnation and global temperature change**.



Our long list of **30 extreme risks** is grouped into six areas, namely:

**Financial (F),
Economic (E),
Political (P),
Environmental (e),
Social (S) and
Technology (T)**

and are labelled in alphabetical order within each category.

The long list of 30 risks

Financial extreme risks essentially revolve around solvency. Can the financial institution pay its debts with available cash? The interconnected nature of the modern financial system and the (still) high levels of leverage mean that insolvency for one institution can quickly become a systemic problem. In this category, we considered three risks: banking crisis (F1), insurance crisis (F2) and sovereign default (F3).

Economic risks are described as arising from a shock to growth, a shock to price levels, or a collapse in trust (which is essential for the efficient working of any economic system). Growth shocks can take the form of a depression (E5) or stagnation (E7). The former has a painful contraction phase but then relatively swift recovery, compared to stagnation where growth is weak for an extended period. Price level shocks can occur in opposite directions: rapid rises in hyperinflation (E6) and falling prices in deflation (E4). 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 (abandonment of fiat money, E1), in the value of a major currency (currency crisis, E3), or in the economic system as a whole (break-down of capitalism, E2).

Political extreme risks comprise those which derive from policy decisions. In two of the cases the link is direct and obvious. Global trade collapse (P2) follows policy decisions to favour protectionism over openness and globalisation, and World War III (P5) follows an active decision to declare war. For anarchy (P1) and political extremism (P3) the link is less direct, but in both cases poor prior policy decisions are likely to be a necessary, if not sufficient, condition for these risks to foment. Terrorism (P4) is included in the political category due to its ideological foundation, and as the target chosen for the act of terrorism is likely to have political ramifications. Please note that we are considering extreme manifestations in this paper. Terrorism is a weekly, if not daily, occurrence somewhere around the world and so the extreme risk would be a terrorist act comparable to, or worse than, 9/11.

Environmental risks are threats to human safety and well-being arising from a disruption to planet earth’s environment. If we draw the boundary of the system around the earth and its atmosphere, then two of these risks – alien invasion (e1) and cosmic threats (e3) – would be exogenous. Is an alien invasion too extreme to spend any time seriously considering? Quite possibly. After all, both the probability of the event and the consequences are unknowable. However, risk management is about taking action in advance to prepare for possible future consequences and the value of the exercise is in scanning

the horizon with an open mind. We can always apply further filters at a later stage to protect our finite risk management resources (in fact alien invasion does not make it into the top 15 risks we focus on in this paper). Two of the environmental risks, biodiversity collapse (e2) and global temperature change (e4), could be caused by humanity, and would thus represent serious own-goals. The final risk in this category is natural catastrophe (e5). As earthquakes, for example, happen every day the extreme version of this risk is either a confluence of extreme natural catastrophes (think magnitude 10 earthquake, combined with a 25 metre tsunami, helped along by a category five windstorm) or the eruption of a super volcano. This is the downside of living on a planet that regularly brings to the surface useful and valuable minerals.

Social extreme risks are those threats that could adversely affect the smooth functioning of society. It should be noted that the categories we are discussing are not independent and it should be clear that the social risks link to policy decisions, the environment, and, in some cases, to technology. This is obvious in the case of food/water/energy crisis (S2) which will have political, environmental and technological drivers as well as offsets. Three of the risks are health related. Pandemics (S5) are a favourite of commentators on extreme risks, as in relative terms there is plenty of good data. For our purposes we postulate a new disease agent that hits the “disease sweet spot” of high infectivity and high mortality (these are typically trade-offs). Health progress backfire (S3) refers to a reversal in the trend of improved health while, in the other direction, extreme longevity (S1) becomes a risk when viewed through the lens of a retirement provider. In most other contexts it would be considered a boon. The final risk in this category is the growth in organised crime (S4) to the extent that legitimate economic activity ceases to be viable in the (major) country or region concerned.

Our final category of extreme risks concerns **Technology**. These risks range from a failure in current technology (nuclear contamination, T4 and infrastructure failure, T3), through the possible consequences of emerging technology (cyber warfare, T2 and biotech catastrophe, T1), to the unknowable future event of the technological singularity (T5). The latter risk refers to the point in time when humans have designed super-intelligence into machines. What happens beyond that point is unknowable and therefore the subject of speculation. The extreme version has already been foreshadowed in various fictional films where the machines replace their human creators.

For interested readers, we provide detailed descriptions for each of these 30 risks in the appendix.

Assessment framework: likelihood, impact and uncertainty

For this exercise to be useful we cannot stop at the identification and simple listing of the risks. We need to assess them in order to determine which ones are more material and which are less. As alluded to earlier, our assessment framework is three-dimensional:

1	2	3
<p>Assessment of likelihood has a four-point scale representing a likelihood of occurrence of one-in-10 years, one-in-20 years, one-in-100 years, and less likely than one-in-100 years.</p>	<p>The potential impact of the risk is split into two separate dimensions, namely the intensity and the scope (or geographical and temporal spread)</p> <ul style="list-style-type: none">▪ The intensity is assigned to one of three states that are labelled endurable, crushing, and existential. Consider yourself in the three states. An endurable risk could represent a broken leg; crushing might imply the loss of a limb, or paralysis; and existential could refer to the loss of self-awareness or loss of life.▪ The scope of the impact attempts to convey both spatial and temporal information by use of four categories: local, global, trans-generational and pan-generational. The first two imply a temporary impact while the latter two imply a lasting impact. We use “trans-generational” to describe an impact that will affect more than one generation but that would then fade or reverse. Pan-generational is used to describe an impact that would affect all subsequent generations, or all previously potential generations (such as extinction of the human species)⁶.	<p>The final score assigned to each risk is uncertainty which is assessed as low, medium, or high, including uncertainty regarding the likelihood and uncertainty regarding the impact.</p>

⁶ We have drawn on and adapted the qualitative risk categories of Nick Bostrom

Our assessment of each of the extreme risks in all three dimensions is shown in the table below:

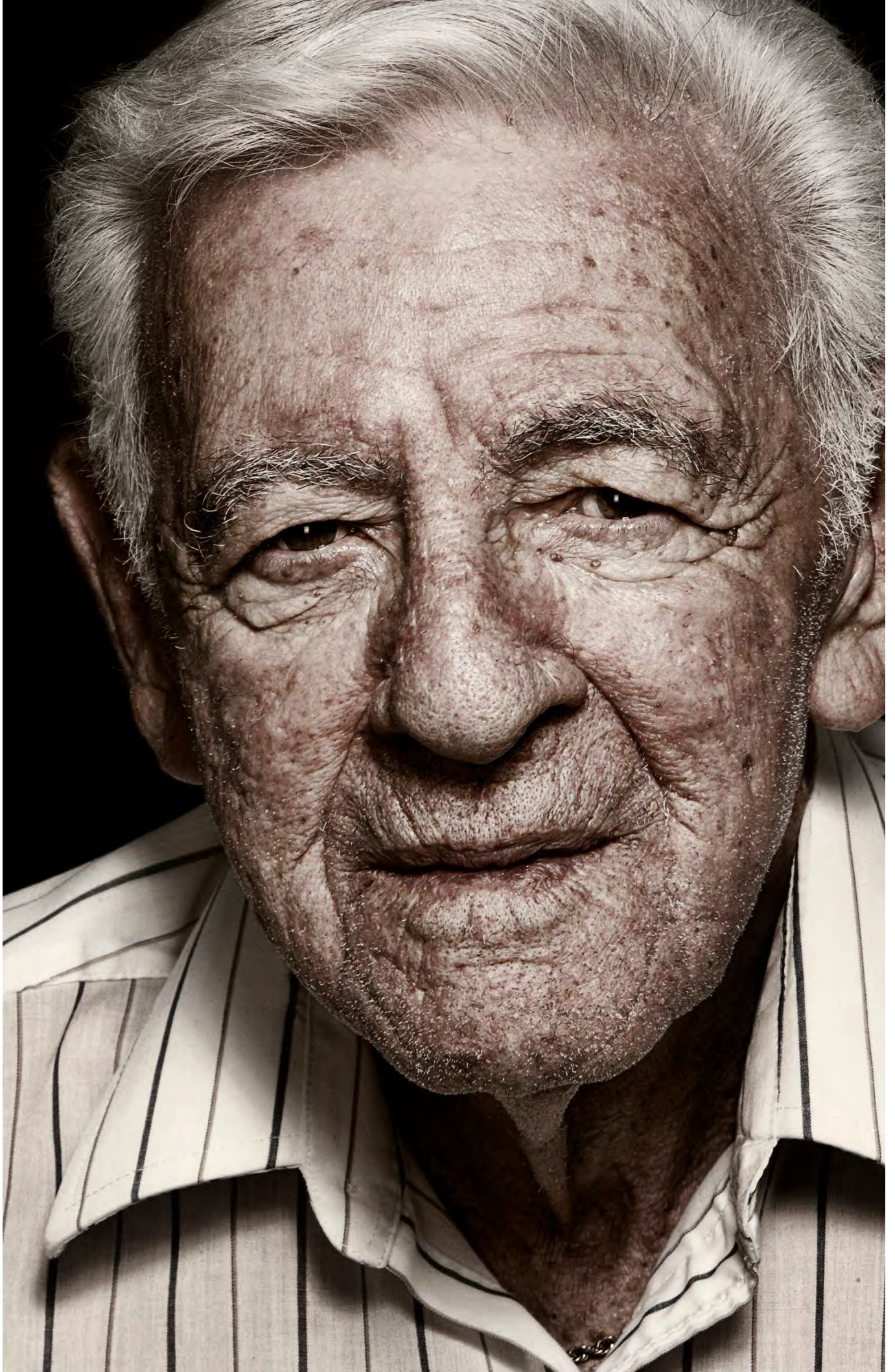
Risk	Likelihood	Uncertainty	Impact – Intensity	Impact – Scope
P1 Anarchy	2	M	1	1
P2 Global trade collapse	1	M	1	2
P3 Political extremism	2	H	2	1
P4 Terrorism	2	M	1	1
P5 World War III	3	M	2	2
F1 Banking crisis	2	L	1	1
F2 Insurance crisis	3	L	1	2
F3 Sovereign default	2	L	1	1
e1 Abandonment of fiat money	2	M	1	2
e2 Break-down of capitalism	3	M	1	3
e3 Currency crisis	2	L	1	2
e4 Deflation	3	L	1	1
e5 Depression	2	L	2	1
e6 Hyperinflation	3	M	2	1
e7 Stagnation	2	L	1	1
E1 Alien invasion	4	H	3	4
E2 Biodiversity collapse	2	M	2	3
E3 Cosmic threats	4	M	3	4
E4 Global temperature change	2	L	2	3
E5 Natural catastrophe	4	M	2	3
S1 Extreme longevity	3	L	1	2
S2 Food/water/energy crisis	2	L	2	1
S3 Health progress backfire	2	M	1	3
S4 Organised crime	2	H	1	1
S5 Pandemic	2	H	2	2
T1 Biotech catastrophe	3	H	2	2
T2 Cyber warfare	1	M	1	2
T3 Infrastructure failure	1	M	1	1
T4 Nuclear contamination	2	M	2	1
T5 Technological singularity	3	H	3	4

1 = one-in-10 years
 2 = one-in-20 years
 3 = one-in-100 years
 4 = one-in-100+ years

A degree of High (H)
 Medium (M)
 Low (L)

1 – Endurable
 2 – Crushing
 3 – Existential

1 – Local
 2 – Global
 3 – Trans-generational
 4 – Pan-generational



The top 15 risks

The final part of our assessment of these risks is to create a ranking of their importance. This introduces no new information but simply combines the four scores for each risk into a single ranking. The intuition is straightforward. The more likely a risk, the higher up the ranking it should be. Likewise, the less uncertain a risk, the greater the intensity of impact and the larger the scope of the impact, the higher up the ranking a risk should be.

Rank	Risk	Brief description
1	Global temperature change	Earth's climate tips into a less-habitable state (hot or cold)
2	Global trade collapse	A worldwide protectionist backlash against cross-border trade
3	Cyber warfare	Internet being weaponised that causes severe damage to virtual systems vital to the economy and even to hard infrastructure
4	Food/water/energy crisis	A major shortfall in the supply of food/water/energy
5	Currency crisis	Extreme movement between exchange rates
6	Depression	A deep trough in economic output with massive increase in unemployment
7	Infrastructure failure	An interruption of a major infrastructure network
8	Banking crisis	Banking activity halts due to lack of liquidity
9	Sovereign default	Non-payment by a major sovereign borrower
10	Stagnation	A prolonged period of little or no economic growth
11	Biodiversity collapse	A collapse in biodiversity, in which an accelerating number of species decline to extinction
12	Health progress backfire	Massive rise in morbidity or mental ill-health, antibiotic resistance
13	Nuclear contamination	A major nuclear disaster, leading to large radioactivity release and lethal effects
14	Abandonment of fiat money	A complete collapse in trust of governments and governments-backed paper currency
15	Extreme longevity	Significant increase in life expectancy overwhelms support systems



Global temperature change has now climbed to the top spot. Theoretically this covers scenarios of our planet becoming unbearably too hot or too cold (e.g. caused by a nuclear war). But frankly we are not particularly concerned about the latter at this point in time⁷. On the other hand, over the last six years the world has continued to emit increasing amounts of greenhouse gasses that exacerbates the risk of rising global temperature. The passage of time, with no meaningful actions taken, means we are six years closer to the point of no-return. For that reason, we decided to lift the likelihood rating for this particular risk, boosting its ranking to the top as a result. In fact we seriously pondered whether rising global temperature remains an extreme risk. To us, it is looking increasingly likely, suggesting it might need to be considered as a mainstream risk.

The number two extreme risk is the potential collapse of global trade, driven by the rise of protectionism. For anyone who has paid attention to western political development over the last six years, this shouldn't come as a surprise. Nationalism has overtaken globalisation in some of the most advanced economies. US President Donald Trump, who hasn't conducted a real war so far, is busy fighting multiple trade wars with both friends and foes of the US. In the UK, Brexit has cost two Prime Ministers their jobs – and counting – and led to a bleak economic outlook for Britain's⁸ future outside the European Union. The World Trade Organisation admits that global trade growth loses momentum as trade tensions persist. A statistical outlier or genuine turning-point of globalisation? We don't know. But symptoms of rising populism and narrow-minded worldviews are driven by a more tenacious underlying disease: rising inequality. It is unlikely to go away anytime soon.

As the world has become ever more connected in the virtual space, the risk of the internet being weaponised has also increased, resulting in cyber warfare also joining the top three spots. Clear evidence points to targeted cyber attacks on the rise. More than 10 billion malware attacks were blocked in 2018, the most ever recorded to date by the SonicWall.

We would also like to highlight two new joiners to the top 15 extreme risks: biodiversity collapse and abandonment of fiat money. The 2019 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report warns that declines in biodiversity are accelerating as a result of human activity, which in turn threatens people's well-being. Should biodiversity collapse be higher up the ranking than #11? Possibly. In our thinking, biodiversity loss is likely to be a “phase transition problem” – think of changing the temperature of water in one degree centigrade steps. Nothing much happens until, suddenly it becomes solid – or a gas. We think we have been in the benign phase of biodiversity loss – where losing 1% of

⁷ At least we have not learnt anything that makes us more concerned about extreme cooling compared to our previous assessment six years ago.

⁸ The kingdom may not remain united.



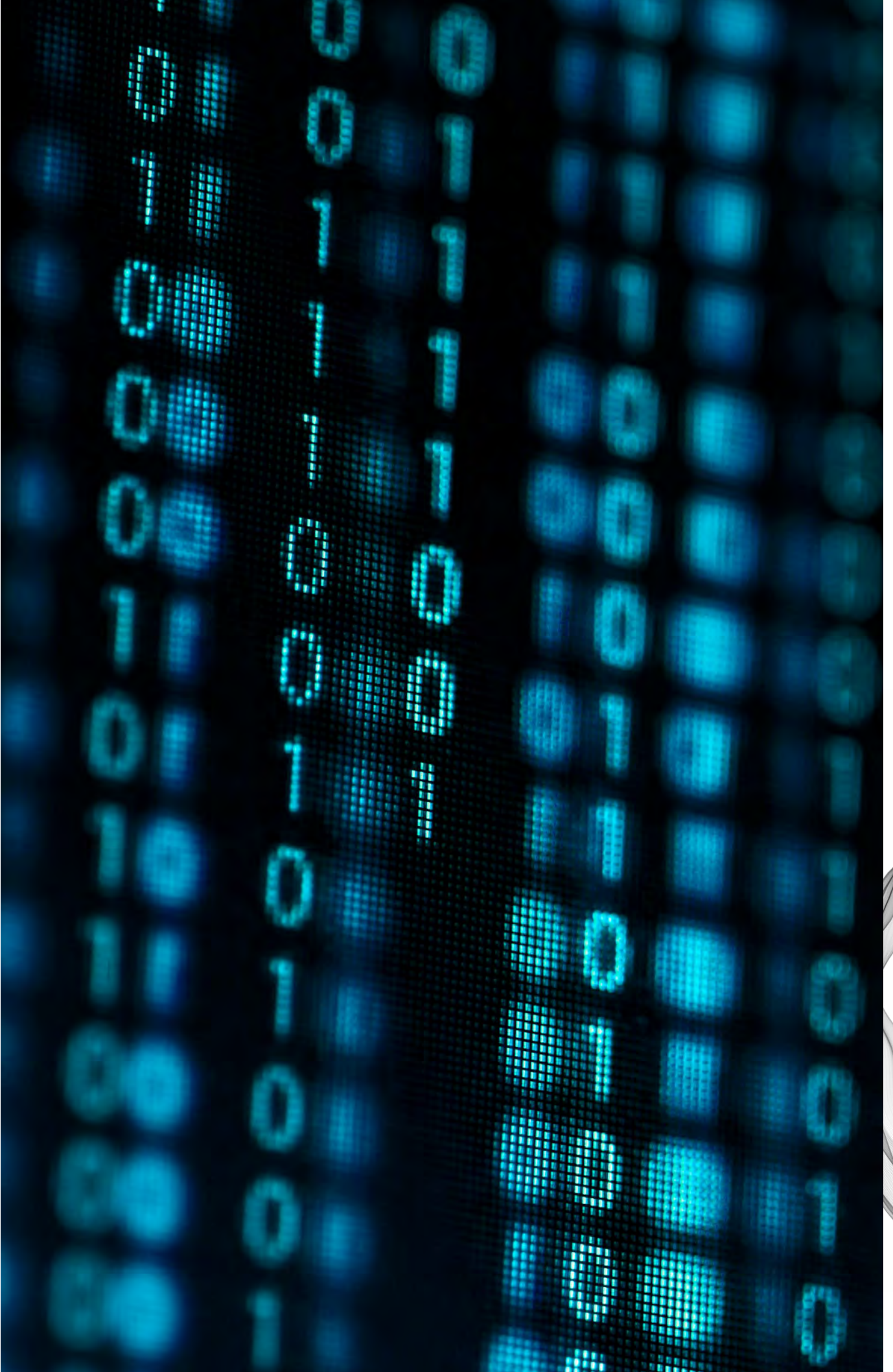


the species doesn't appear to matter, but one of the next 1% losses could change everything. We rely on nature for our life-support systems, and as a store for our not-yet-discovered medicines. We do not know if our thinking is correct nor, if it is, how close we might be from such a tipping point. We therefore cannot be confident that we have ranked this risk correctly.

Over the last six years we have also witnessed the rise of cryptocurrency, notably Bitcoin and Facebook-backed Libra. Is it likely that they will challenge government-backed fiat money anytime soon? No. Is it plausible that they will become an increasingly important part of the global payment and monetary system? Yes. Over time could they reduce or even eliminate the role of fiat money? It would be unwise to rule it out as an extreme risk.

The power of the ranking system is that it combines and trades-off the four risk scores in a consistent manner. Different weights could be applied, but the importance of a ranking system is to challenge pre-conceptions (and mitigate black swan biases). Whatever the weights, the ranking highlights the risks to prioritise when it comes to management actions.





Hedging and investment implications

While interesting in its own right, we believe the consideration of extreme risks can be useful in helping to design more robust investment portfolios and more robust risk-management processes.

The starting point to building a robust investment portfolio and reducing (but not eliminating) tail risks is to introduce greater diversity. It should be noted that diversity is a broader concept than diversification and it refers to having exposure to as broad a number of different risk premia/return drivers as possible, in order to reduce the risk that forecasts about the future are “wrong”. This is one important element of the world view that we are proposing, and which should lead to more consideration of extreme events.



The next step is to explore some hedging strategies. Broadly there are three hedging strategies available to us:

Hold cash. To quote James Montier of GMO, cash is “perhaps the oldest, easiest, and most underrated source of tail risk protection”.⁹

- Over long historical periods cash has held its real value through both episodes of deflation and inflation but there is no guarantee that this will be the case in the future. If an investor views holding cash as too-high an opportunity cost currently, especially in real terms in Western markets, then this will be a difficult option. However, it is possible to view cash as having a high option value, as some sovereign wealth funds do, with that value increasing non-linearly with the degree of market stress experienced
- Derivatives. As an example, pension funds that worry about extreme longevity can purchase a longevity swap. Or they could buy a credit default swap (CDS) to insure against non-payment by a sovereign borrower. It is worth mentioning that cost and usefulness are often in opposition. The cost of derivatives protection can often be reduced by specifying more precise conditions – but the more precise the conditions, the greater the chance that they are not exactly met and hence the “insurance” does not pay out
- Hold a negatively-correlated asset. There is no single asset that will work against all possible bad outcomes. Further, there is no guarantee that the expected performance of the hedge asset will actually transpire in the future event. For example, what hedge can we use against a global temperature change event? The habitable land in the world will be significantly reduced, but assuming that demand for habitable land remains unchanged (ie population is virtually unaffected by the event), the price of that land will likely go up. However there is tremendous difficulty in discovering the “right” land beforehand to include in your portfolio which will not only survive from a highly uncertain global temperature change event but also be free of nationalisation or foreign invasion after the catastrophic event occurs.

Of course, hedging comes with its own set of problems. Not all extreme risks can be hedged, and most hedges used are likely to be very imprecise. Even for risks that can be hedged, the carrying cost of the hedge is likely to be high and almost certain to require the use of derivatives. Therefore thought needs to be given to whether the counterparty would be willing and able to pay out if the bad event happened.

⁹ [A value investor's perspective on tail risk protection: an ode to the joy of cash](#), James Montier, June 2011, GMO white paper

In essence the exercise of considering extreme risks is time spent on “pre-mortems” . While a post-mortem seeks to establish the cause of death, pre-mortems are about trying to determine in advance what could, colloquially, kill you. We believe that being adept at pre-mortems means you are a better risk manager and can react more flexibly in the event of an extreme event happening, particularly as the event is unlikely to evolve precisely along the lines predicted.

Consequently, the obvious application of extreme risk thinking is in stress-testing or scenario learning , but it is also constructive to consider whether the thinking can be incorporated within the process for managing an investment institution’s balance sheet. One option would be to penalise the existing “normal state” assumptions by slightly reducing expected returns, or pushing up volatilities, and/or correlations to reflect the impact of infrequent extreme events. A second option is dynamic switching of some sort. We either build two sets of assumptions (“normal” and “extreme”) or we design a second, extreme-risk portfolio directly from first principles. Then “all” that is left to do is successfully time the switch between the two, not forgetting the need to time the switch back so we can go on harvesting returns when the conditions are conducive.

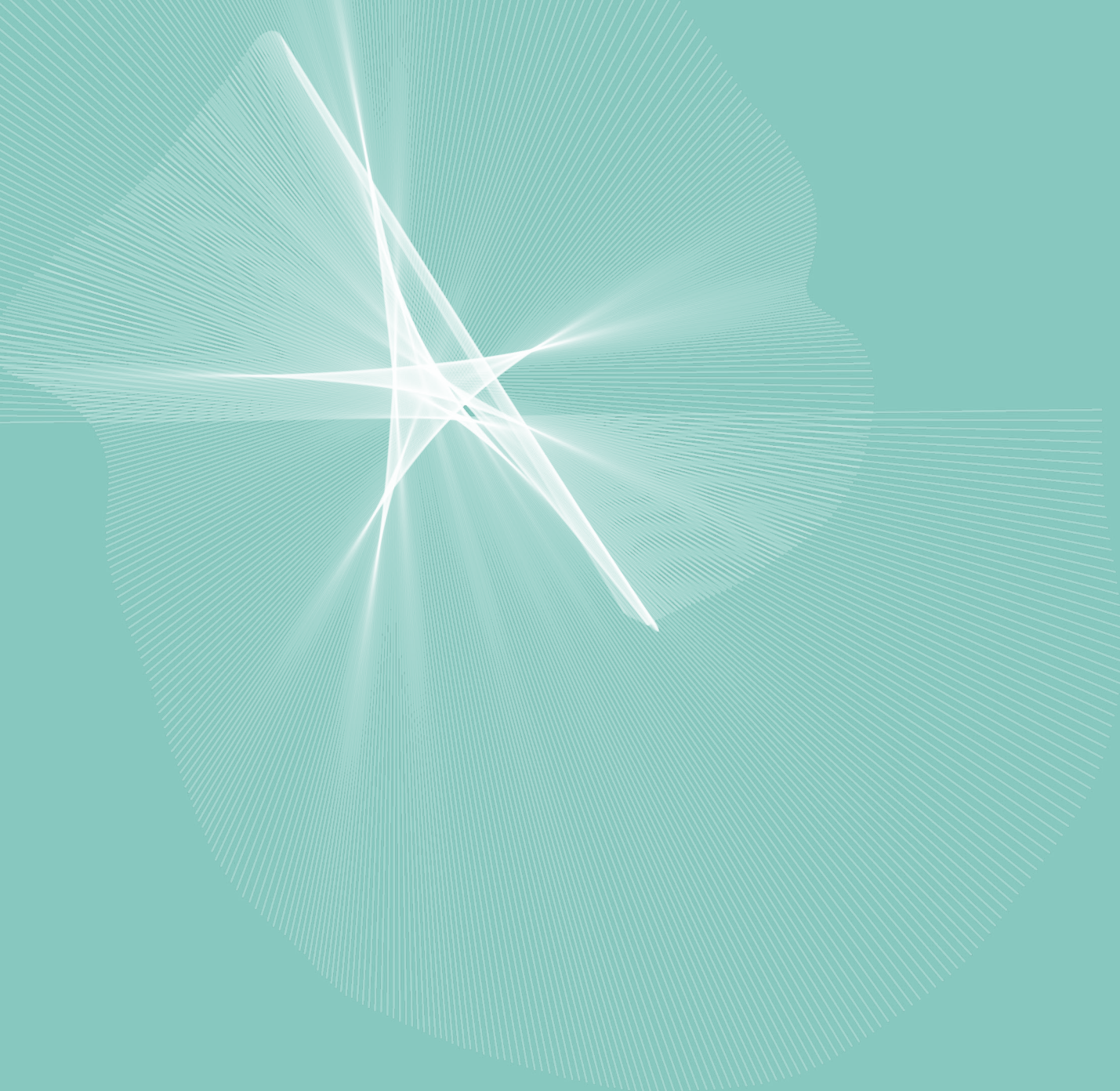
We would also advocate establishing some sort of early-warning system to closely monitor what could develop into extreme events. While this is probably once again one of the areas where things are easier said than done, there has been some interesting research into the area of trying to predict the seemingly “unpredictable”. For example, Didier Sornette and his Financial Crisis Observatory have plotted a set of early-warning signs for unstable, growing systems.

So how should investment institutions actually adapt in recognition of extreme risks? We would suggest a prioritisation exercise: first, worry about the events “that can kill you”, that is permanently impair the investor’s mission. This should identify which extreme risks matter, and which can be ignored. For the former, the right thing to do is to pay up for the insurance, given that the prioritisation exercise has shown the investor cannot afford to self-insure. Second, an investor should do the simple things. These would include ensuring the portfolio is as diversified across as many return drivers as possible; diversifying within asset classes; and creating a strategic allocation to cash to provide optionality. Finally, greater complexity can be added over time, assuming it passes a considered cost/benefit analysis. This is likely to involve adding long-dated derivative contracts in a contrarian manner, that is, when they are cheap rather than popular.

¹⁰ This Thinking Ahead Institute research on [better decision-making](#) shows how to conduct a pre-mortem exercise.

¹¹ To truly harvest the power of scenario learning, we hope this Thinking Ahead Institute paper - [It's story time: The why, how and what of scenario learning](#) - can help you.

¹² This is explained in a talk given by Didier Sornette, the director of the Financial Crisis Observatory (http://www.ted.com/talks/didier_sornette_how_we_can_predict_the_next_financial_crisis.html)



Appendix

The Appendix provides greater detail on each risk. This section is far from exhaustive (an entire paper could be written on each risk) but should give the reader a clear picture of each extreme risk event and spur reflection on its implications and priority to their organisation.

Banking Crisis

Category: Financial

Background and underlying factors	Event description	Potential consequences
<p>Banking crises have occurred in the past, for example:</p> <ul style="list-style-type: none"> ▪ In 1907 a recession in the US included a panic run on banks, leading to many failures ▪ In 1927 the Shōwa financial crisis resulted in mass bank failures across Japan ▪ In the 1930s the worst systemic banking crisis of the 20th century led to the Great Depression ▪ In the early 1970s the UK experienced a banking crisis that required government intervention ▪ In the 1980s, the US experienced a banking crisis within the savings and loan sector of its banking system, with wide-scale failures ▪ In 1998, the collapse of Long-Term Capital Management required a banking industry bailout to prevent a wider crisis. <p>The most recent banking crisis, GFC, was actually a series of crises including those in Iceland, Ireland, the UK, the US, Spain, Greece, and Italy.</p> <p>Banking crises are driven by two interrelated factors. The first is a panic, in which depositors believe the banks will fail and seek to withdraw their funds, leading to a liquidity-driven crisis. The second is a balance sheet crisis in which asset values collapse leading to capital shortages. The latter can be caused by excessive loan defaults, collapses in the value of collateral, or investment losses on assets held by the banks.</p> <p>Developments that threaten future bank solvency could include (1) a continued drop in real estate prices, (2) increased corporate defaults and (3) poor economic conditions in general.</p>	<p>The event would be some form of global financial crisis in which banks would be unwilling or unable to supply liquidity to borrowers, because they suffered losses in the value of the assets they held, including losses on the loans they had made. As bank capital ratios fell, depositors could panic and seek to withdraw funds. In such a crisis, government nationalisation of the banks is a distinct possibility.</p>	<p>Financial markets seize up, with an ensuing flight to quality; credit spreads widen in the process.</p> <p>Credit shortages transmit to the real economy, adversely impacting trade and business activity.</p> <p>Economic activity declines rapidly, with the potential for a depression; alternatively, government intervention staves off the depression, but stagnation occurs.</p> <p>With the greater possibility of nationalisation of the banks, the state of government finances could become an issue, as efforts to bail out the banks could lead to sovereign defaults, creating a currency crisis.</p>

Insurance Crisis

Category: Financial

Background and underlying factors	Event description	Potential consequences
<p>While smaller insurer insolvencies are relatively commonplace, widespread failures on a global scale are relatively rare.</p> <p>The closest the insurance industry has come to a global crisis in modern times is the inflationary period of the 1980s, which caused casualty insurance liabilities to increase dramatically. Many smaller insurers failed, and many major insurers were forced to exit the market by being acquired (Aetna, Home, USF&G, and Continental are US examples). In the UK, Lloyd's of London required a rescue plan to avert its collapse.</p> <p>In addition to monetary inflation, the 1980s were characterised by 'social inflation', in which both individual and corporate liability for injurious acts was dramatically expanded. Insurers did not recognise these trends and failed to raise prices to cover their costs. In addition, many insurance supervisors suppressed price increases for political reasons.</p> <p>An insurance crisis could be spawned by asset non-performance, as well as liability cost expansion. A collapse of an entire asset class, such as sovereign debt might cause this. Finally life insurers are subject to disintermediation risk as the interest rate credited on their policy obligations could be above the yields on their invested assets.</p>	<p>The event would be a rash of insurer insolvencies across the globe, either due to declining asset values or rising liability costs, leading to non-performance on in-force insurance contracts and a global supply shortage of new insurance coverage.</p> <p>Surviving insurers may withdraw from markets due to perceived levels of risk. As insurer capital ratios fell, some classes of policyholders could create a "run" by seeking to withdraw funds from policies with cash value, or moving existing coverage to other insurers.</p>	<p>Existing mechanisms that deal with insurer insolvencies (such as the "guaranty funds" established in the US) would likely be overwhelmed by the volume of claims against them; government intervention to back-stop these mechanisms would be required, but may not be forthcoming in all markets.</p> <p>Adverse wealth effects are experienced by beneficiaries.</p> <p>Availability shortages for mandatory coverages such as automobile, property, and health would disrupt the real economy; auto and real estate sales couldn't close because insurance requirements couldn't be met.</p>

Sovereign default

Category: Financial

Background and underlying factors	Event description	Potential consequences
<p>Sovereign default ('restructuring' is the more polite euphemism) refers to non-payment by a sovereign entity of its obligations. Sovereign defaults have been surprisingly common, and not just among emerging countries. It is easily possible to document over 140 sovereign defaults over the centuries (less strict definitions would yield many more) – and that number includes the likes of Germany, France, Italy and Japan in the 20th century.</p> <p>There is clearly a benefit to defaulting – not paying back what you owe allows you to consume more immediately (and possibly into the future).</p> <p>The costs associated with sovereign default fall into two broad types – penalty costs and output costs. Penalty costs are the higher rates charged by external creditors to obtain borrowing in the future. Output costs refer to the drop in production and therefore consumption of the defaulting nation.</p> <p>There has been much alarmist talk about the size of recent budget deficits and hence the required amounts of sovereign debt in developed economies. Sovereign default is more likely if economic growth remains stuck at a low level; if taxes are not or cannot be increased; and if governments do not (or cannot) reduce spending. The likelihood also increases when the tax burden falls on workers who don't believe the debt is their responsibility (the next generation).</p> <p>Sovereign default is usually preceded by several actions: regulatory changes (wide range of possibilities from changing state pension benefits, tax rates, permissible investments etc); covert sequestration (for example tax breaks for holding government bonds); or compulsory sequestration (forced conversion of cash to government bonds, making the holding of gold illegal etc).</p>	<p>The event would be an extreme level of sovereign default, by a major country or group of countries, in which their obligations are 'restructured' in a way that is economically adverse to the obliges.</p> <p>In all likelihood the event would create a crisis of confidence causing the value of other sovereign debt to plummet, and leading to substantial movements in currency exchange rates.</p>	<p>In the short run the defaulting country is better off because it has reduced its costs, making room for higher consumption.</p> <p>Given the scale of the default, it would be likely to cause market panic and adversely disrupt the global economy; investors would likely flee 'bad' asset categories in exchange for those that were believed to be 'safe'.</p> <p>Equity markets would also fall, as uncertainty about the implications would be widespread.</p> <p>As domestic banks tend to be large holders of sovereign debt, particularly just before a default, the act of default can trigger a banking crisis and therefore an economic crisis.</p>

Abandonment of fiat money

Category: Economic

Background and underlying factors	Event description	Potential consequences
<p>The fiat money system, exclusively used in every major economy nowadays, is the system where a government agrees to accept paper money in payment of taxes and debts. Fiat money is declared by a government to be legal tender (the term derives from Latin and means 'let it be done'), and therefore does not have any intrinsic value. Its value is dependent on the relative scarcity and the degree to which people trust it.</p> <p>A gold standard is associated with a government guarantee that paper notes are freely convertible into pre-set, fixed quantities of gold. Since the collapse of the Bretton Woods system in 1971, we have been living in a fiat-money world. From a historical point of view, however, a repeated shifting between fiat and gold standards is normal. The US has thus far avoided hyperinflation by shifting back and forth between a fiat and gold standard over the past 200 years. In a fiat money system, central banks have no upper limit to an expansion of the money supply while in a gold standard system the supply of money is limited by the relatively stable (in the long term) pace of gold mining. The choice is then between a stable economy but unstable monetary policy (fiat money) and a stable monetary policy but unstable economy (gold standard). Since the global financial crisis, money creation around the globe has prevented another depression. All of these efforts would be impossible under a gold standard structure. Nonetheless, should these efforts result in rising inflation or even hyperinflation the return to a gold standard (or switch to an alternative standard) would have a higher probability in future. A deepening distrust of fiat money among investors would have long term investment implications, for example an intensified search for alternative assets as a store of value. Before gold ever came back as a 'standard' it would be likely to benefit from any increasing distrust of central banks and the paper money they issue.</p>	<p>The event would be a declaration by one or more major governments that it was returning to the gold standard (or any non-fiat-money based standard), in an effort to deal with a collapse in confidence in its paper currency, typically to control monetary inflation.</p> <p>This could occur as an agreement among a group of nations, but that might not be the case; the action could be unilateral.</p> <p>The declaration could cause substantial shifts in currency rates, as investors moved their holdings between gold-standard and fiat money currencies.</p>	<p>Under a gold standard, there would be much less opportunity for monetary policy, so the economy would likely become more volatile.</p> <p>Currency exchange rates among those countries adopting the gold standard would become more stable, but exchange rates with those not moving to the standard might move significantly.</p> <p>A big discovery of gold would be inflationary; otherwise prices would stabilise in the long run.</p>

Break-down of capitalism

Category: Economic

Background and underlying factors	Event description	Potential consequences
<p>The headline here is not that capitalism is in crisis but that “capitalism is the crisis”. It is the ultimate economic extreme risk where distrust in the private capital/property system causes a collapse in economic activity and asset prices.</p> <p>Capitalism’s basic premise is that the pursuit of self-interest and the right to own private property are morally defensible and legally legitimate. In a pure capitalist economy, the market drives the allocation of resources and any economic decisions. In contrast, socialism advocates public ownership, in which governments determine the means of production and the allocation of wealth. Arguably, however, a fully market-driven economy (i.e. textbook capitalism) has never existed, and neither has a completely centralised economy.</p> <p>Inequality in all its forms (income, wealth, access to healthcare, education, employment etc) is likely to be the causal factor in triggering this risk.</p> <p>In our view, the most likely scenario is moving along from one end of a spectrum where market is king (minimum regulation) to the other end where we could see more onerous regulations and government intervention and control of the economy. The extreme risk, however, is the demise of the capitalist system and the end of the market as the primary means of resource allocation.</p>	<p>The event would be an overturning of the capitalist system, with a concurrent shift to socialism. Government would explicitly assume the management of the economy, including what is produced and consumed, and how income and wealth is to be distributed.</p> <p>The overturning of capitalism would not require a ‘revolution’ in the sense of governmental overthrow. It could be accomplished by changes to existing law and regulation, coupled with a change in public acceptance of socialism (perhaps with a different label) and a rejection of capitalism.</p>	<p>As governments take on resource allocation, the (private) investment activities will collapse or even be terminated. A large amount of wealth destruction is likely during the transition period.</p> <p>Low productivity will result in sluggish economic growth. [NB the new consciousness would not see economic growth or investment returns as central].</p> <p>Centralised power increases the problem of corruption which inflicts substantial economic costs.</p> <p>The economy is likely to be subject to extreme uncertainty and a higher risk of failure.</p> <p>Investors should probably worry more about the return of their investments rather than the return on their investments.</p>

Currency crisis

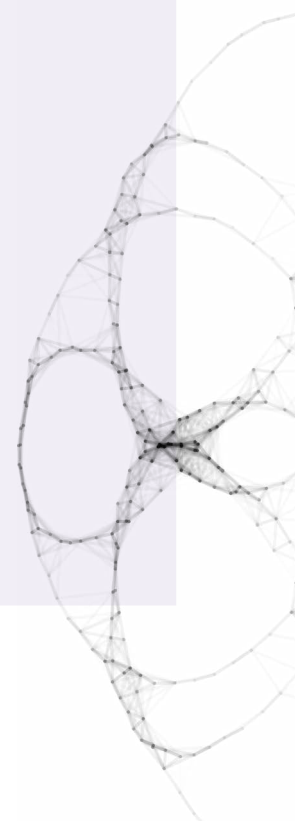
Category: Economic

Background and underlying factors	Event description	Potential consequences
<p>Currency crisis is an alternative term for balance of payment crisis and is therefore, technically, the breaking of a fixed exchange rate. In a looser sense, it can also mean an expectation of a significant self-fulfilling devaluation of a major currency.</p> <p>Ideally economic management is used to maintain balance and control currency exchange. This could be through policies to make domestic business more efficient (thereby raising exports) or adjusting interest rates up or down to attract or deter capital inflows. Therefore the movement in the exchange rate can be thought of as a safety valve that had to blow because other (painful) economic adjustments were not made – for example, raising interest rates, raising taxes, or reducing foreign tariffs.</p> <p>For a fixed exchange rate, the crisis will manifest itself when the central bank runs out of reserves and can no longer defend the exchange rate.</p>	<p>The event would be a significant devaluation of a major currency that disrupts the world economy by altering the balance of international trade.</p> <p>The lower value of the currency would make imported goods more expensive relative to domestic goods, favouring domestic production; hence imports of foreign goods would decline, hurting the economy of trading partners.</p>	<p>A currency collapse severely reduces a country's purchasing power and hence wealth.</p> <p>To the extent that domestic borrowing has occurred in foreign currencies, the cost of servicing that debt will rise dramatically, and hence immediately increase the risk of default.</p> <p>The direct impact on asset values and returns is through the currency, and depends on whether the currency movement is hedged or not: domestic investment in domestic assets will be unaffected; domestic investment in foreign assets will benefit substantially; investment by foreigners in domestic assets will suffer substantially.</p> <p>The indirect effects are more complicated, as the crisis will only have occurred because of some underlying economic imbalance.</p>

Deflation

Category: Economic

Background and underlying factors	Event description	Potential consequences
<p>Deflation refers to economic conditions in which prices for goods and services fall for a sustained period.</p> <p>Historically not all episodes of deflation correspond with periods of poor economic growth, particularly when deflation was caused by technological progress that created significant increases in productivity. The 'disinflation' we have experienced can be attributed to this effect, as robotics, supply-chain management, and other technologies have increased productivity substantially. New techniques for extracting energy sources have also contributed. Productivity gains can manifest themselves as higher unemployment as workers are displaced.</p> <p>A deflationary spiral is an especially problematic situation where decreases in price lead to lower production, which in turn leads to lower wages and demand, which leads to further decreases in price - creating a vicious circle, where the problem exacerbates its own cause. The Great Depression was regarded by some as a deflationary spiral.</p> <p>Deflation increases the real value of debt, causing a transfer of wealth from borrowers to savers. Confused pricing signals cause under-consumption and under-investment at the cost of jobs and future economic growth. Keynesian economics describes this as a liquidity trap, in which people hoard cash because they expect deflation, leading to insufficient aggregate demand. In this scenario, central banks are incapable of stimulating the economy by lowering interest rates (in a liquidity trap short-term interest rates are typically near zero). In Keynesian economics, the only remaining available lever is fiscal policy; running large deficits to increase aggregate demand.</p>	<p>The event would be a global deflationary spiral, with falling prices over a sustained period, transferring wealth from borrowers to savers.</p> <p>The event may or may not be accompanied by a shrinking economy, even a depression.</p>	<p>A long period of persistent deflation can be severely detrimental to economic growth; it is usually accompanied by rising real interest rates, drastic declines in output and persistently high unemployment. Stagnation is likely.</p> <p>Deflation should result in slower growth and rising real debt service costs, which will depress corporate earnings growth and equity returns. The increase in the real discount rate will have a further negative impact on equity prices.</p>



Depression

Category: Economic

Background and underlying factors

Most are familiar with the Great Depression in the 1930s. Precipitated by the collapse of a major stock market bubble and exacerbated by government policies (tightening of money supply, erection of trade barriers), economic activity shrank dramatically. Some economists have suggested that it took a World War to lift the US out of the depression.

The current risk of depression in the West appears to have been reduced through policy action but remains an extreme risk – in that it may not be possible for governments to counteract any future drop in demand, should that occur. There has been an extended period of over-consumption (by Western consumers) meaning that businesses have built productive capacity to satisfy a level of demand that is unlikely to be reached for a number of years, as Western households increase their savings rate.

Event description

The extreme risk event is a rapid and painful contraction in economic activity in one or more major economies, leading to a deep decline in output, massive increase in unemployment, restriction of credit, and shrinking investment, in a major economy.

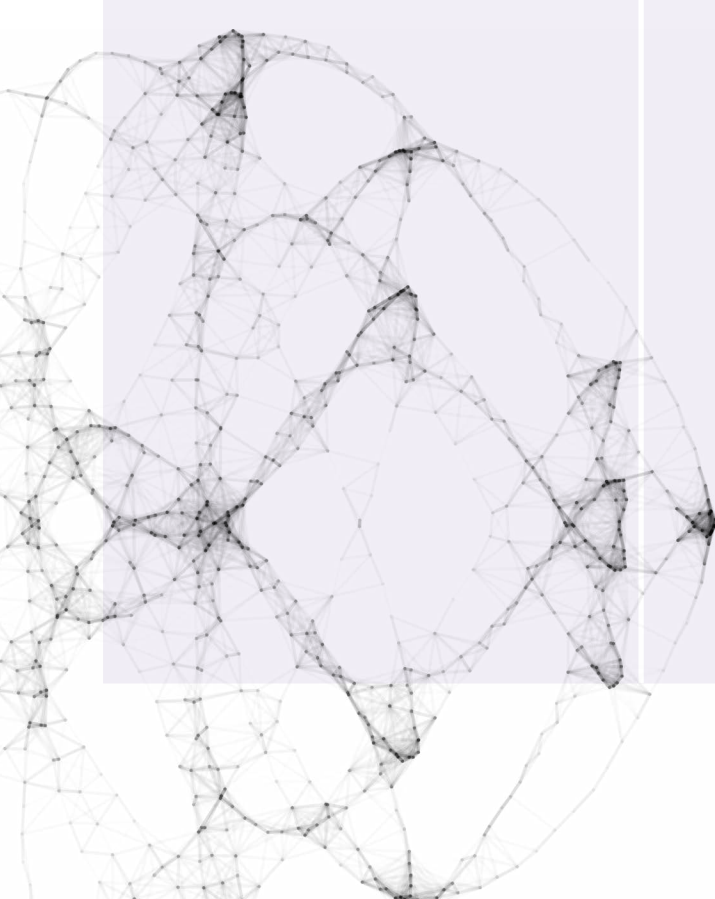
Potential consequences

The primary consequence of a depression is typically a sharp and prolonged increase in unemployment. The depth of the trough means that a long period of recovery is required before there is pressure to hire new workers.

The subsidiary effects are therefore a drop in consumption, restriction of credit, shrinking output and investment, and numerous bankruptcies. A banking crisis is likely to be a consequence.

Depressions can trigger deflation or hyperinflation, adding further complication.

Excessive leverage in the system can interact with depression – a self-reinforcing fall in asset values can cause further defaults, bankruptcies, falling incomes and rising unemployment, causing or prolonging economic depression.



Hyperinflation

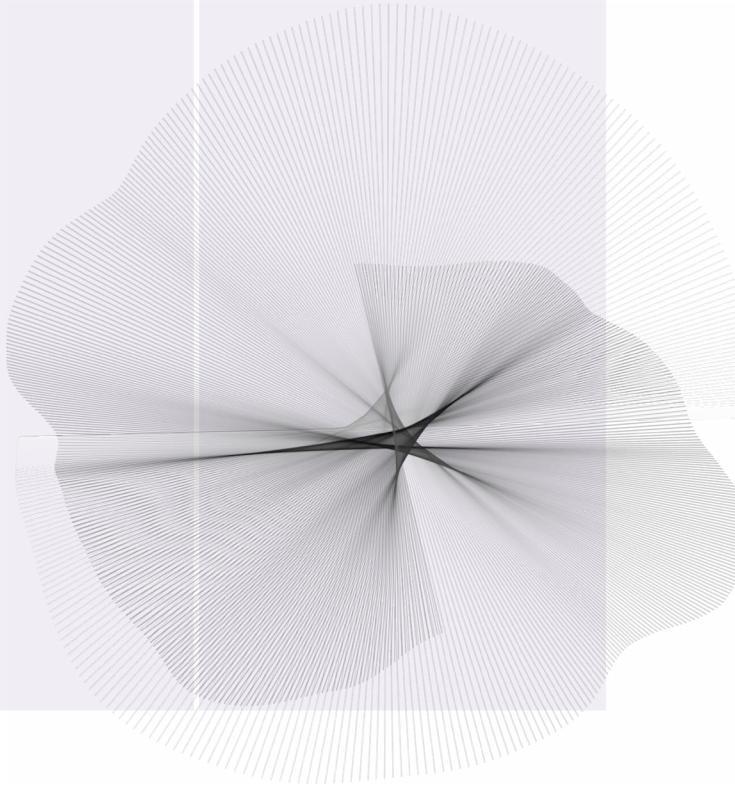
Category: Economic

Background and underlying factors	Event description	Potential consequences
<p>The traditional quantity-theory-of-money view tends to attribute hyperinflation to unchecked budget deficits, leading to a rise in the supply of money and consequently higher prices.</p> <p>James Montier of GMO provides an alternative view that money supply is endogenous, and that budget deficits are often caused by hyperinflation rather than being the source. He discovers that hyperinflation shares several common characteristics such as large supply shocks, big debts denominated in a foreign currency and distributive conflict/transmission mechanism.</p> <p>Regardless of the debate about the root causes of hyperinflation, it is usually accompanied by a widespread unwillingness to hold the money for more than the time needed to trade it for something tangible to avoid further loss. Hyperinflation wipes out the purchasing power of savings, provokes extreme consumption and hoarding of real assets, causes the monetary base to flee the country, and precipitates cessation of investment.</p> <p>Historically, there have been numerous episodes of hyperinflation in various countries, followed by a return to 'hard money' (some form of non-devaluing medium of exchange).</p>	<p>The extreme risk event is inflation being very high or 'out of control' in a major economy, a condition in which prices increase rapidly as money loses its value, wiping out savings, provoking extreme consumption, and hoarding of real assets.</p> <p>Definitions used by the media vary from a cumulative inflation rate over three years approaching 100% to 'inflation exceeding 50% a month'. As a rule of thumb, hyperinflation is often reported for short intervals, often per month.</p>	<p>Hyperinflation is often associated with wars (or their aftermath), economic depressions and political or social upheavals. The general population loses confidence in the local currency, preferring to keep its wealth in non-monetary assets or in a relatively stable foreign currency. Amounts of local currency held are immediately invested to maintain purchasing power. Prices may be quoted in a foreign currency.</p>

Stagnation

Category: Economic

Background and underlying factors	Event description	Potential consequences
<p>Compared to depression, which we define as starting with a very painful contraction followed by faster growth, stagnation is a prolonged period of little or no economic growth, usually accompanied by high unemployment.</p> <p>Economic stagnation can be caused by excess leverage in the system and the subsequent prolonged period of deleveraging. It could also be the result of catastrophic events or demographic trends.</p> <p>One of the latest and widely researched cases of economic stagnation is the so called “lost decade(s)” for Japan since the early 1990s, when its massive asset price bubble collapsed in a catastrophic manner, aggravated by a declining and ageing population. Japan’s economy has stagnated for more than two decades since and its real GDP growth rate from 1990 onwards has been less than 1% per year, noticeably less than the growth rate achieved in the decades before the stagnation. During the same period, Japan also experienced a secular decline in the employment-to-population ratio and a secular increase in the unemployment rate. Persistent deflation became a norm. Despite the deflation, real earnings declined steadily which limited the growth in real private consumption.</p>	<p>The event would be a prolonged period of little or no economic growth in a major economy, usually accompanied by high unemployment and growing political dissatisfaction as the quality of life does not improve or even declines.</p>	<p>Economic stagnation is normally associated with low real interest rates; in such an environment nominal bonds tend to outperform, while risky assets such as equity suffer.</p> <p>Deflation is a likely consequence.</p> <p>Stagnation can foster political unrest, as the lack of economic growth and declining incomes fuel dissatisfaction.</p>



Anarchy

Category: Political

Background and underlying factors	Event description	Potential consequences
<p>Social unrest can stem from a variety of factors, including the performance of government in providing fair treatment of its citizens and delivering a rising quality of life.</p> <p>Unfortunately we live in a world where inequality is rising, potentially contributing to a profound level of dissatisfaction, especially during times of economic stress. Clashes between religions, and their proper role in government, could be a contributing factor. Demography could also be a factor, as aging populations demand support from a shrinking workforce. And, new technologies offer hyper-connected communication, making it is easier for a disaffected public to organise itself to orchestrate protests.</p> <p>The Arab Spring (2010) removed existing rulers in Tunisia, Egypt, Libya and Yemen, prompted by these types of factors. In Egypt, the replacement government was removed because it did not deliver improvements in basic services. China saw 8,700 'mass incidents' in 1993 rise to approximately 200,000 in 2010, highlighting an increasing threat to the stability of world's second largest economy. In Europe protests have been seen over immigration and climate.</p>	<p>The event would be an extreme form of social disorder in a major country, typified by mass demonstrations with widespread looting and rioting, directed against the government and related institutions. Work stoppages and infrastructure damage would likely interfere with the delivery of basic goods and services. The disorder would be sufficiently extreme to result in the loss of power by the government.</p>	<p>Delivery of basic goods and services are disrupted. Workers are unable or unwilling to do their jobs, and businesses close. Unemployment rises, and the economy shrinks substantially or collapses.</p> <p>Loan defaults create a banking crisis.</p> <p>Lack of confidence and balance of trade issues create a currency crisis.</p>



Global trade collapse

Category: Political

Background and underlying factors	Event description	Potential consequences
<p>Protectionism is the policy of restricting trade with the aim of 'protecting' businesses and workers in the domestic economy from the full force of external competition.</p> <p>The last wave of major protectionism were tariffs introduced in the 1930s to 'counteract' the depression. These had the opposite effect.</p> <p>Since World War II the trend was for the steady, gradual reduction in trade barriers through the formation of the EU and other trade initiatives although reversal in globalisation is evident in recent years. There have been a number of studies that suggest an increase in barriers to trade since the global financial crisis.</p> <p>The concern is that short-term political expediency can override long-term economic logic with the extreme risk being a populist backlash against cross-border mobility of labour, goods, and capital, causing global trade and investment to collapse.</p>	<p>The event would be an extreme populist backlash against cross-border trade, labour mobility, and foreign investment, causing politicians to enact substantial barriers. As other countries would be expected to retaliate, a collapse in global trade and investment would occur.</p>	<p>The consequences will include more uncertainty in financial markets, greater fragmentation of capital markets and eventually a reversal in globalisation.</p> <p>The world economy would likely shrink, as foreign markets became closed to local businesses.</p> <p>Since more goods would need to be produced locally, some domestic businesses would flourish, at least in the short run; however, global efficiency would be lost, which is likely to trigger a wave of inflation.</p> <p>The potential for a food, water, or energy crisis exists.</p>



Political extremism

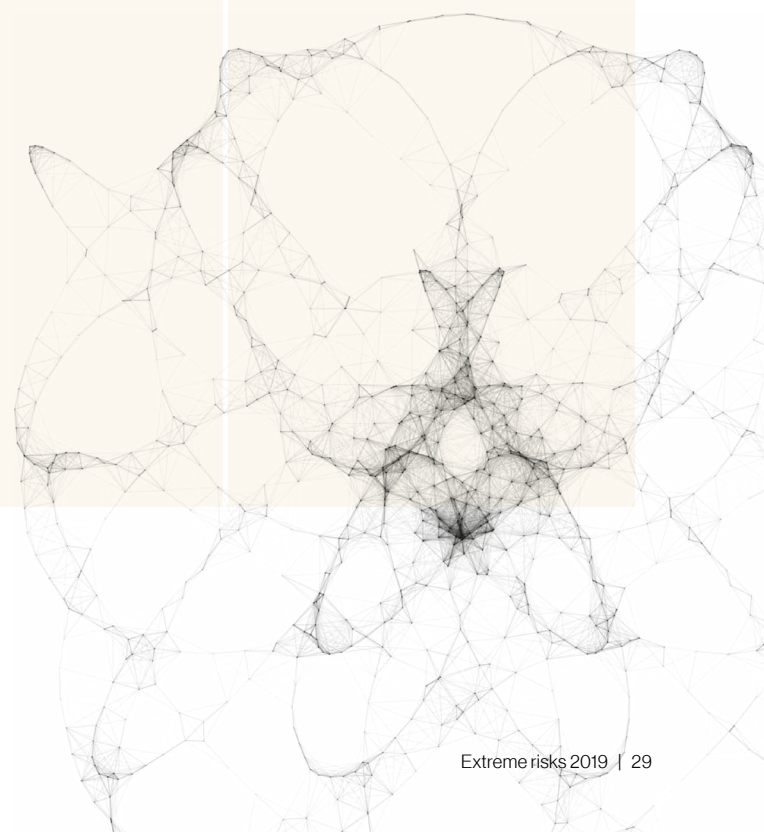
Category: Political

Background and underlying factors	Event description	Potential consequences
<p>During the twentieth century, many nations suffered under extraordinarily brutal governments, which intended to hold total authority over the society and seek to control all aspects of public and private life (totalitarianism). The Soviet Union and Nazi Germany are the two most-studied totalitarian regimes.</p> <p>The risk of political extremism is defined by the rise to power in a major economy of an oppressive government (including but not limited to totalitarianism). Political extremism typically causes a large number of civilian deaths (by modern calculations, the Soviets killed approximately twenty million civilians, the Nazis twenty-five million) and could become a major threat to global peace (Nazi Germany directly caused World War II).</p> <p>Bryan Caplan from George Mason University speculates that the chance of a world-wide totalitarian government emerging during the next 1,000 years – and lasting for 1,000 years or more – is about 5%.</p>	<p>The event would be the rise to power of an oppressive government in a major economy. As was the case in Nazi Germany, the rise could be a take-over and transformation of an existing government, rather than a revolution. In such a scenario, at least a portion of the public would acquiesce to the transformation. Any dissidents in opposition would be crushed by the new regime.</p>	<p>Suppression and murder of the opposition.</p> <p>War, to the extent that other countries were the focus of expansion for the regime; eventually countries that felt threatened might have no choice but to join together and fight.</p> <p>A contemporary totalitarian regime is likely to engage in economic war with the rest of the world, seeking to disrupt foreign businesses and protect domestic businesses; foreign trade is likely to collapse.</p>

Terrorism

Category: Political

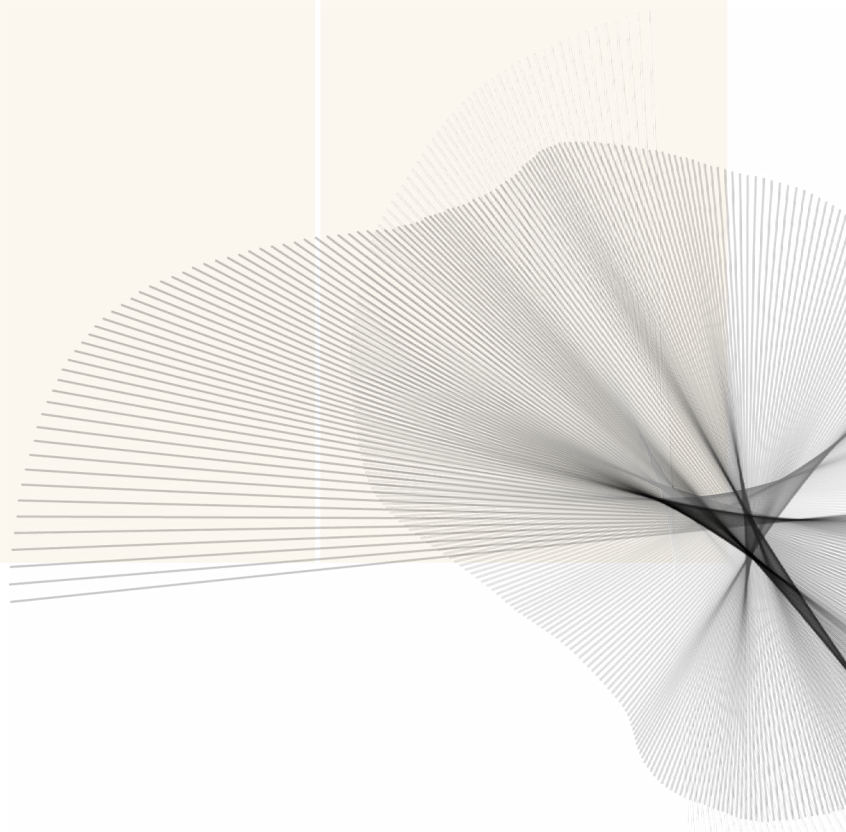
Background and underlying factors	Event description	Potential consequences
<p>The September 11 attacks on the World Trade Center and Pentagon caused almost 3,000 deaths, and destroyed several billion dollars' worth of property.</p> <p>In the period of uncertainty that followed, the Dow Jones Industrial Average fell by more than 14% in the week after the New York Stock Exchange reopened. Markets around the world, although not directly affected, also fell.</p> <p>Locally, business interruptions were substantial. It is estimated that New York City's GDP lost \$27.3 billion in the ten-year period from 2001. More broadly, public uncertainty as to whether there would be more attacks, and what the economic impact of the attack would be caused a pause in purchases, most visibly with new car sales.</p> <p>The impact of 9/11 extended beyond geopolitics into society and culture in general.</p>	<p>The extreme risk event is a major ideologically-driven terrorist attack of a similar or even larger scale than 9/11, targeted at a region of global economic and/or political importance and inflicting large-scale human and financial damage. The event would be at a scale sufficient to disrupt daily life for a significant population and have an impact on the global economy.</p>	<p>The event is likely to be accompanied by some form of infrastructure failure.</p> <p>Financial markets could be disrupted, more significantly than in 9/11.</p> <p>While the U.S. government succeeded in getting the public to quickly return to 'business as usual', that might not be the case in another event. Unease about the future (the threat of further attacks) could cause a significant drop in consumption, leading to a recession.</p> <p>A migration away from targeted areas could occur, as people might have fears about safety.</p>



World War III

Category: Political

Background and underlying factors	Event description	Potential consequences
<p>One consequence of war is the destruction of capital – both physical and human. War tends to kill those in prime ages (predominantly males), which leaves a reduced younger workforce and in turn reduces economic output and consumption. World War II caused between 65 and 75 million deaths, and the total number of deaths in wars and conflicts for the entire 20th century was between 136.5 and 148.5 million according to one estimate.</p> <p>In addition to the loss of human life, whole cities were destroyed where the campaigns were conducted. Business activity and support systems had to be completely restarted afterwards.</p> <p>The availability of weapons of mass destruction means the next world war could destroy an order of magnitude more capital than the previous ones. As Albert Einstein put it: 'I know not with what weapons World War III will be fought, but World War IV will be fought with sticks and stones'. The invention of nuclear and biological weapons raises the possibility that the future war could put much of the human race at risk.</p>	<p>This extreme risk is a military war involving many of the world's most powerful and populous countries causing multiple-millions of deaths, and destruction of property on a massive scale.</p>	<p>Global trade would be significantly disrupted, as would global financial systems; some assets would be frozen, and commodity shortages would likely create additional hardship.</p> <p>In areas directly affected, general economic activity would be disrupted; outside of the campaign theatres, business activity would be diverted to support the war effort.</p>



Alien Invasion

Category: Environmental

Background and underlying factors	Event description	Potential consequences
<p>An alien invasion is a very common theme in science fiction despite the fact that evidence of extra-terrestrial life has never been documented. NASA's Kepler mission to identify earth-size planets around stars was launched in March 2009 and has already discovered thousands of candidates.</p> <p>The closest historical analogy to an alien invasion is the arrival of the Europeans in the Americas, intending to colonise the New World. While the extermination of the Native Americans wasn't an explicit part of the colonist's plans, it turns out that this was partly accomplished by inadvertent means. The early explorers brought smallpox and other diseases with them, for which the Native Americans had no immunity. By the time the Pilgrims arrived, it is estimated that roughly 90% of the Native Americans had died. The colonists found whole villages deserted and land cleared but unplanted. In addition the survivors were weakened and afraid, and therefore unable to repel the waves of arriving colonists.</p> <p>The colonial example underscores the uncertainty associated with an alien invasion, illustrating that it can unfold in unforeseen ways.</p>	<p>The extreme risk is an invasion of non-peace-seeking extra-terrestrials that look to either remove the planet's resources, or enslave or exterminate human life.</p>	<p>The range of outcomes of an alien life contact can be vast and entirely unpredictable but if the contact is indeed hostile it is more likely that the human race is unable to defend itself due to the potentially overwhelming technological gap.</p>

Biodiversity collapse

Category: Environmental

Background and underlying factors	Event description	Potential consequences
<p>It is estimated that less than 1% of the species that have existed on earth are extant, and there have been five known mass extinctions since life began on earth that led to large and sudden drops in biodiversity.</p> <p>Human activity has accelerated the species loss and these losses could reach a point beyond which it becomes irreversible.</p> <p>It is believed by some scientists that earth is currently experiencing its sixth mass extinction. Although about 80% of humans' food supply comes from just 20 types of plant, humans use at least 40,000 species. Earth's surviving biodiversity provides resources for increasing the range of food and other products suitable for human use, although the present extinction rate shrinks that potential.</p>	<p>The event would be a collapse in biodiversity, in which an accelerating number of species decline to extinction. The process could be a 'death spiral', in which the disappearance of one species would initiate the decline of others due to their inter-dependency. In essence, the earth's ecosystem would be destroyed.</p>	<p>The destruction of the world's ecosystem can cause the loss to humans of ecosystem services: provision (food and clean water), regulation (climate and disease), support (nutrient cycles and crop pollination) and culture (spiritual and recreational benefits).</p> <p>It is likely that the loss of these services would lead to a broader economic collapse, and either to war or anarchy.</p>

Cosmic threats

Category: Environmental

Background and underlying factors	Event description	Potential consequences
<p>There are risks arising beyond earth, such as a major meteorite impact, being pulled out of orbit (or the solar system) by a passing asteroid, or a giant solar flare (the effects of which would be compounded if during a reversal of the earth's magnetic field).</p> <p>A ten kilometre wide meteorite (like the one that hit earth around 65 million years ago causing, as widely believed, the extinction of dinosaurs) could release 100 million megatons equivalent of energy. It is estimated that such a meteorite could trigger magnitude 10 earthquakes and a 300-metre high tsunami spreading to all of the earth's coastal regions, costing millions if not billions of human lives. Noxious gases and dust would then accumulate in the atmosphere cutting out sunlight and potentially terminating all lives that survived the direct impact – a mass extinction event.</p>	<p>The event would be an extreme cosmic occurrence, such as a major meteor striking the earth, a significant disturbance to the earth's orbit by a passing asteroid, or a giant solar flare - any of which could have a major impact on the physical aspects of the planet.</p>	<p>The impact of these events could range from severely inconvenient to existential.</p> <p>A big enough solar eruption could trigger a magnetic storm and damage electricity distribution lines or disable critical communication and navigation systems.</p>

Global temperature change

Category: Environmental

Background and underlying factors	Event description	Potential consequences
<p>There is little doubt in science that we are experiencing a period of rising global temperature. Increasingly the scientific community is pointing to rising greenhouse gas emissions from human activities as the root cause.</p> <p>Natural feedbacks (e.g. the ice-albedo feedback, in which melting ice reveals darker land and water surfaces below, which absorb more solar heat, causing more melting and warming) in the system have the potential of amplifying global warming. Global warming is expected to be followed by serious consequences including extreme weather being more frequent, and rising sea levels (of several meters) making much of the current coastal communities uninhabitable.</p> <p>On the other hand, while gaining less support in the science community, earth's surface and atmosphere could experience excessive cold slipping into an ice age. This could be caused by a drop in the sun's emission of energy (for a temporary but prolonged period), or by another extreme event such as a meteorite strike or super volcano which would spread ash into the atmosphere creating a global winter.</p>	<p>The extreme risk event is that earth's atmosphere passes a point of no-return, and tips into a less-habitable state (either hot or cold), disrupting social and economic systems.</p>	<p>Habitable areas will be significantly reduced, causing large scale migration and reducing the quality of life for most of humankind; economic stagnation is a possible consequence, as is a health progress backfire.</p> <p>Food production will be disrupted, as existing arable land becomes too hot and dry (or flooded at wrong point of season).</p> <p>Rising sea levels will necessitate inland migration.</p> <p>Coastal properties will lose value and become uninsurable; inland properties will rise in value.</p> <p>Extreme weather of all types, and related hazards such as wildfires, will disrupt property insurance markets; rebuilding will become a more significant part of the economy.</p>

Natural catastrophe

Category: Environmental

Background and underlying factors	Event description	Potential consequences
<p>These are the disasters resulting from natural processes of the earth including earthquakes, tsunamis, hurricanes, flooding (including atmospheric river storms) and volcanic eruptions.</p> <p>The extreme risk would either be a confluence of connected extreme natural catastrophes (e.g. a magnitude 10 earthquake, causing a giant tsunami and triggering volcanic eruptions) or the eruption of a super-volcano. The latter would cause global effects on climate from the ash fallout and aerosol clouds (volcanic winter).</p> <p>It is believed that a super-volcanic event at Lake Toba around 71,000 years ago led directly to a cooling event that lasted over a thousand years.</p> <p>While not yet statistically significant, there is growing evidence that weather phenomena such as hurricanes, windstorms, blizzards etc are becoming more severe, and that the frequency of severe events is rising.</p>	<p>The event would be an extreme natural catastrophe event on an unprecedented scale, include a mega-earthquake or a super volcano; it could also take the form of a season of hurricanes or other weather events at a frequency and severity that is unprecedented - with major impacts.</p>	<p>Massive property losses, on an unprecedented scale.</p> <p>Going forward, insurance in affected areas would become unavailable or unaffordable.</p> <p>Agriculture collapse as a result of the loss of one or more growing seasons.</p> <p>Decline in health (famine and spread of infectious disease).</p> <p>Transportation disruption (air travel halted for years).</p> <p>Utilities (electrical, communication, gas, oil) offline for an extended period, making some areas uninhabitable.</p>

Extreme longevity

Category: Social

Background and underlying factors

A major breakthrough in medical or human genome science – it is hoped that the cure for common banes such as heart disease, cancer and stroke may be in the offing – could result in an unanticipated, significant increase in life expectancy for everyone, or the majority of people.

In addition, even though life expectancy has increased steadily in recent history, these gains do not necessarily lead to better health in later life. The risk therefore also includes an emergence of a society with a growing number of the elderly who suffer chronic but non-fatal diseases – people live longer but their ‘productive’ years stay more or less the same.

Event description

The event would be a significant advance in medicine or genome science that significantly increases life expectancy, either by curing common diseases or delaying the ageing process itself.

Potential consequences

A direct impact of longer lifespans on defined benefit pensions and annuities is increased liabilities; these systems could be overwhelmed by the additional cost of promised benefits.

The economy will struggle to support the needs of a growing mass of the elderly who are in need of long-term health care and other support services.

To the extent that governments are involved with pensions, either as payers or guarantors, they could be overwhelmed fiscally, spawning a sovereign debt crisis.

Intergenerational politics will be stressed, as a smaller workforce will be asked to support a growing retiree group.

Food/water/energy crisis

Category: Social

Background and underlying factors	Event description	Potential consequences
<p>It was estimated in 2010 that 600 million people in 21 countries were facing either cropland or freshwater scarcity, and that number is projected to increase to 1.4 billion people in 36 countries by 2025.</p> <p>Over one billion people live in areas where human use of available water supplies exceeds sustainable limits and by 2025 this figure is projected to rise to 1.8 billion, with up to two-thirds of the world's population living in water stressed conditions.</p> <p>On the energy side, the supply of fossil fuels has a known limited time span while no viable alternatives are currently available with comparable energy returns on energy invested (EROEI). There is a risk that the necessary technological breakthrough will not arrive in time to prevent a global economic collapse due to an energy crisis.</p> <p>Consequently, given the current fine balance between supply and demand and the projections of demand growing faster than supply for food, water, and energy, we see this as a particular area of vulnerability.</p>	<p>The extreme risk event is the occurrence of a major shortfall in the supply of, or access to, food, water, or energy for a large proportion of the world's population, causing severe societal issues.</p>	<p>Particularly in the case of food and water, a crisis could lead to widespread death and damage to the quality of life for many survivors; economic stagnation could occur.</p> <p>Nations may go to war to take the resources they need from those who have them; for example OPEC nations could be attacked to gain access to their oil.</p> <p>Energy shortages, and food shortages for workers, could cause a significant decline in output.</p>

Health progress backfire

Category: Social

Background and underlying factors	Event description	Potential consequences
<p>In the movie I am Legend, a virus originally developed as a cure for cancer turns out to cause mutations (such as the inability to be exposed to sunlight), but the mutations are not discovered until after the virus has been used to immunise most of the population. Society and the economy collapse, as a few who are immune seek an antidote.</p> <p>Modern medicine has been consistently meeting existing and new diseases with new treatments, giving rise to improved human health. There is no guarantee that the rate of medical advancement can always outpace the rate of pathogen evolution and a catastrophic event could emerge should biological mutation eventually outpace human innovation. This could result from the unintended consequences of current healthcare practices such as antibiotic resistance.</p> <p>The World Economic Forum warns that we are decades behind in comparison with the historical rate at which we have discovered and developed new antibiotics and none of the drugs currently in the development pipeline would be effective against certain killer bacteria.</p> <p>Social trends such as widespread mental health problems and obesity are additive to the problem. Stephen Petranek, then editor-in-chief of Discover magazine, points out that despite improved physical health, the human race is mentally falling apart – one in five people in the West is believed to be clinically depressed.</p>	<p>The event would be a massive rise in morbidity or mental ill-health for a large proportion of the population, perhaps due to an unintended consequence of a new health practice.</p>	<p>Both the quality of life and economic output would be degraded.</p> <p>Health-care costs would rise dramatically.</p> <p>There may or may not be a reduction in longevity; lifespans could be unaffected.</p>

Organised crime

Category: Social

Background and underlying factors	Event description	Potential consequences
<p>Organised crime is a common reality for most if not all countries.</p> <p>The UK Home Office suggests that organised crime costs the UK between £20 and £40 billion each year and its impact is felt by the state, businesses, communities, families and individuals.</p> <p>Organised crime was very strong in the US during Prohibition in the 1930s, providing a substantial business opportunity to which the general public did not object. When Prohibition was repealed the government was able to exert better control over the reach and influence of organised crime.</p> <p>The drug cartels in parts of Latin America where cocaine is produced are a modern-day example of the extent to which organised crime can become ingrained into the fabric of society.</p>	<p>The extreme event is a significant increase in the scale of illegal operations by organised crime in a major economy, to the extent that legitimate economic activity becomes non-viable.</p>	<p>Extreme form organised crime could bring severe disruptions to normal activities in affected areas, typically associated with high homicide rates, wide use of illegal drugs and the collapse of legal business activity potentially followed by social unrest.</p>

Pandemic

Category: Social

Background and underlying factors	Event description	Potential consequences
<p>Recent pandemics (eg SARS, avian and swine flu, Ebola), despite being contained (for now?), demonstrate how easily deadly viruses can mutate.</p> <p>History is full of significant pandemics with an extremely high number of casualties. For example, it is believed that Plague of Justinian in AD 541-542 killed 50% of the world's population; the Black Death in the 13th century caused the death of one-third of the population of Europe, and 'Spanish flu' during 1918-1919 killed 20 to 50 million people.</p> <p>Of course, many of the above pandemics occurred before the advent of modern medicine. For example, the Black Death is believed to have been a bacterial infection which would, today, be treated with antibiotics. However, the current threat of antibiotic resistance suggests that we should not be too complacent about the ability of medical solutions to respond quickly to new strains of bacteria and viruses.</p> <p>Pandemics can be attended by high morbidity within a very short period of time (e.g. influenza), increasing the difficulty for effective vaccines to develop in time. Modern travelling patterns make it almost impossible to contain a contagious disease within a specific region.</p> <p>While we have relatively more knowledge about human disease pandemics than other events, there is still the possibility of surprises.</p> <p>Pandemics among animal or plants are also a reality. A more recent instance is the precipitous drop in the bee population, which is believed to include a virus as one of the causal factors.</p>	<p>The extreme event is a pandemic of a new, highly infectious and fatal disease that spreads quickly through human, animal or plant populations worldwide, with catastrophic consequences.</p>	<p>A substantial spike in mortality.</p> <p>Rather than being fatal, the disease could be permanently injurious (like polio), creating a whole class of people with higher morbidity.</p> <p>If it were necessary to restrict travel, business activity could be affected.</p> <p>Absenteeism could adversely affect core services, like hospitals, air traffic control, etc.</p> <p>Animal or plant pandemics could adversely affect food supplies.</p>

Biotech catastrophe

Category: Technological

Background and underlying factors	Event description	Potential consequences
<p>The cost of DNA sequencing and synthesising has reduced massively over the years. Nasty nucleotide sequences such as the Ebola virus and the 1918 influenza virus are accessible online and genetic engineering of viruses is much less complex and far less expensive than sequencing human DNA. This makes it a lot easier to apply this technology to destructive uses than constructive ones.</p> <p>Adding to the problem is the fact that the biotech industry is highly unregulated. Regulating and controlling current and new developments would require strong global governance which the world currently lacks.</p>	<p>The event would be an instance where biological technology (genome, nano-technology, viruses, etc.) is applied in a destructive way, either intentionally or inadvertently, with catastrophic consequences.</p>	<p>Consequences could range from disruption to extinction, and are uncertain.</p>

Cyber warfare

Category: Technological

Background and underlying factors	Event description	Potential consequences
<p>In the movie Live Free or Die Hard, cyber terrorists hack into government and commercial computers across the US with the goal to start a “fire-sale” of financial assets. Electricity grids, traffic control systems, natural gas pipelines, communication networks and television are all disrupted via their computer networks. The film was based on the 1997 article A Farewell to Arms published in Wired magazine.</p> <p>Cyber crime is a daily reality. This extreme risk is cyber warfare, and refers to politically-sponsored computer hacking to conduct sabotage and espionage on a national or global scale.</p> <p>It is reported that a series of cyber-attacks on businesses and institutions in the US have prompted fears of a looming ‘cyber cold war’. Former US Defense Secretary Leon Panetta predicted a cyber-version of Pearl Harbor might soon take the US by surprise.</p> <p>Social security, financial and medical systems connected to the internet could all become the target of cyber-attacks.</p> <p>A cyber-attack on the defence system can be expected to precede a military attack in all future wars.</p>	<p>The event would be computer sabotage or espionage on a major scale, with severe damage to hard infrastructure, financial services systems and networks, communications networks, corporate systems, medical support systems, or defence systems.</p>	<p>Cyber war could cause severe damage to physical infrastructure – bridges, tunnels, air traffic control, electricity grids and energy pipelines; this damage could easily be of a scale to disrupt business and economic activity.</p> <p>Financial records could be altered or destroyed on a massive scale, essentially wrecking the financial system.</p> <p>Ground traffic in major cities could be put into sustained gridlock, disrupting all aspects of life.</p>

Infrastructure failure

Category: Technological

Background and underlying factors	Event description	Potential consequences
<p>This extreme risk refers to an interruption (prolonged but not permanent) of a major infrastructure network due to either human activity (e.g. cyber-attack), natural disasters (e.g. earthquake or flooding), or even cosmic threats (e.g. giant solar flare).</p> <p>The eastern US has been subjected to multiple electricity blackouts since the 1970s. While the blackouts lasted only a matter of hours, they unnerved the public, as they were unaccustomed to such events.</p> <p>We saw a glimpse of the potential impact of infrastructure failure after Storm Sandy hit metropolitan New York. Subways and power in lower Manhattan were out for over a week, power outages in the suburbs lasted a month or more, spot-shortages of gasoline were prevalent, and utility services for the most-affected areas took more than six months to be restored. The affected citizens were very angry that “no one was coming to help them” with these infrastructure problems.</p>	<p>The event is an extreme interruption of a major infrastructure network, disrupting business activities or impacting basic needs of a large population for a period sufficiently long to be disruptive.</p> <p>An example would be the loss of the electricity grid in a population centre for an extended period, particularly during the winter in colder climates.</p>	<p>An extended shut-down of a critical network or electricity grid would bring increasing disruption to economies within the geographical area of impact.</p> <p>People’s basic needs would be threatened in such circumstances raising the possibility of social unrest and law-breaking behaviours for survival.</p> <p>A food, water or energy crisis could be spawned by an infrastructure failure.</p>

Nuclear contamination

Category: Technological

Background and underlying factors	Event description	Potential consequences
<p>It is reported that there were 99 accidents at nuclear power plants between 1952 and 2009 (defined as incidents that either resulted in the loss of human life or more than US\$50,000 of property damage), totalling US\$20.5 billion in property damages.</p> <p>One of the worst nuclear contamination events to date is the Chernobyl disaster which occurred in 1986 in Ukraine, killing 30 people directly, causing thousands of indirect deaths due to radiation-induced cancer, as well as damaging approximately US\$7 billion of property.</p> <p>Even the threat of contamination can be disastrous, as shown in Japan following their earthquake and tsunami. While some radiation was apparently released, the larger effects have been the shutdown of Japan's entire nuclear generation system. This decision will have far-reaching economic repercussions. Nuclear contamination can also be a direct consequence of a nuclear terrorist attack or a full-blown nuclear war among nations.</p>	<p>The event is a major nuclear accident or attack, more significant than Chernobyl, that leads to lethal effects on a large population of individuals and a major radioactivity release to the environment.</p>	<p>Fatalities and high morbidity for those directly affected.</p> <p>A food, water or energy crisis could be spawned by a nuclear contamination event.</p> <p>Loss of property value in the affected area, as residents migrate away.</p> <p>Disruption in electricity generation, as plants are shut down for safety checks; potential for a permanent loss of nuclear electric generation capacity.</p>

Technological singularity

Category: Technological

Background and underlying factors	Event description	Potential consequences
<p>It is possible that the creation of a computer more powerful than the human brain, which can then design and build an even more advanced machine, would create an environment where human survival is at risk.</p> <p>In the Terminator movies, Skynet achieves self-awareness, perceives humans as a threat, and attempts to exterminate the human race.</p> <p>Ray Kurzweil, a futurist, made a prediction in 2006 that the “singularity”, in which a computer will be constructed that is capable of intelligent thought at the level of humans, is likely to occur in the next twenty years. A key premise is that technology is expanding exponentially, while people typically extrapolate linearly.</p> <p>However, while Kurzweil views the event optimistically, Bill Joy, former Chief Scientist at Sun Microsystems, has argued that “21st century technologies – robotics, genetic engineering, and nanotech – are threatening to make humans an endangered species” because “they share a dangerous amplifying factor: they can self-replicate”.</p> <p>Another possibility is a so-called nanotechnology ‘grey goo’ scenario, in which nano-robots self-replicate in an uncontrolled manner and eventually consume everything on the earth. The University of Cambridge has established a research Centre named ‘The Centre for the Study of Existential Risk’, devoted to studying possible catastrophic threats posed by present or future technology.</p>	<p>The event is a technological advancement that extends beyond the point of human understanding or control, including a computer capable of independent intelligent human thought, the development and deployment of self-replicating nanotechnology, a breakthrough in advanced robotics or a substantial step forward in genetic engineering.</p>	<p>Consequences are highly uncertain and potentially existential to human race.</p>

Limitations of reliance

Limitations of reliance – Thinking Ahead Group 2.0

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The Thinking Ahead Institute seeks collaboration and change in the investment industry for the benefit of savers. It was established in January 2015 by Tim Hodgson and Roger Urwin, who have dedicated large parts of their careers to advocating and implementing positive investment industry change. It is a global not-for-profit research and innovation group made up of engaged institutional asset owners, asset managers and service providers committed to changing and improving the investment industry. Currently it has over 40 members around the world and is an outgrowth of Willis Towers Watson Investments' Thinking Ahead Group, which was established in 2002.

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- Find and connect people from all corners of the investment world and harnesses their ideas
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