

# Extreme Risks

## The 2011 Update

By Tim Hodgson, Carole Judd and Liang Yin

Towers Watson has just updated its 2009 list of 15 potential extreme risks to the world's economic and political stability. The current list sees some changes in ranking and includes two new entrants. This article describes the changes and discusses possible hedging and asset allocation implications.

Extreme risks are potential events that are very unlikely to occur but would have a significant impact on economic growth and asset returns should they happen. The global financial crisis and its aftermath have demonstrated that risk management efforts cannot afford to stop at the 95th percentile ( $VaR_{95}$ ), and a holistic risk management framework should include very unlikely, but potentially high-impact, events. This is an update of the extreme risks paper we wrote in 2009.

### Two Years Ago

By way of context, in 2009, we identified 15 extreme risks, which were categorized into three groups:

- *Financial* extreme risks revolve around solvency and whether an institution is able to pay its debts with available cash. In an interconnected, modern financial system, high levels of leverage can mean insolvency for an institution and can quickly become a systemic problem. The primary triggers for

financial risks are falling asset prices and falling incomes. These risks can also be generated by a recession in the real economy and transmitted to the financial sector through defaults on loans. Financial extreme risk examples include another banking crisis or an insurance crisis.

- *Economic* extreme risks are less homogenous, ranging from a deflationary depression to hyperinflation and a return to the gold standard. These risks have their genesis in imbalances, which create instability. Imbalances such as household debt relative to income, government debt relative to GDP, government revenue relative to expenditures and imports relative to exports are all around us. While the correction of imbalances can occur smoothly, there is plenty of potential for nonlinear, and therefore painful, jumps.
- *Other* extreme risks relate to environmental and political themes. If we consider the way we are treating the environment, and the political structures we have (or more importantly, do not have) for dealing with it as well as with financial and economic issues, then we end up with a greater chance for nasty surprises. Political crisis, major war, climate change and a killer pandemic are included in this group.

### What Has Changed?

As our thinking has developed during the past two years, we have identified two new extreme risks. For practical reasons, we kept our list to 15 and dropped two of the previous entries: the end of capitalism because it is so extreme and impossible to hedge, and excessive leverage because of a double counting of financial risks — all the financial risks in our list are essentially associated with too much debt.

The new entrants on the list are resource scarcity and infrastructure failure.

“In 2009, we identified 15 extreme risks, which were categorized into three groups: Financial, Economic and Other.”



## Resource Scarcity

The concept of resource scarcity encompasses just about any necessary resource: oil, energy, metals, water or arable land. The central argument is the likely mismatch between the (linear) evolution of the supply curves for finite resources, and the (exponential) change in demand curves because of population growth and increasing living standards. Much of this increased demand is expected to come from China and India, the two most heavily populated countries, with fast-growing economies. Technology optimists argue that technological advancements can help meet the increasing demand. But certain resources — such as water or arable land — have no easy substitutes, and the extreme risk is a “what if” scenario where technology fails to rescue us or comes too late.

What are the consequences? In the world of economic textbooks, supply and demand are brought into balance through changes in price and/or quantity. The main issue is the difference between the expected supply/demand balance and the actual balance achieved. This is the source of shocks to expectations — whether felt through price spikes or through rationing of quantity. If a major input to the modern economy such as oil eventually runs out without a suitable substitute, both economies and lifestyles would be greatly impacted. Air travel would once again become something only the richest could enjoy. The world would be different from the world we know today. And if water shortages became acute in certain regions, lives would be threatened, and any resulting wars or protectionism could severely impact global development.

## Infrastructure Failure

Infrastructure failure is the risk posed by the dependence of modern economies on computer networks and power grids. Its cost would rise exponentially the longer the networks were not in operation. The wide use of computing technology makes all critical infrastructure networks, whether power plants or financial clearing systems, vulnerable to security breaches and cyber attacks. A prolonged shutdown of a critical network or electricity grid would disrupt economies within the affected geographical area. People’s basic needs would be threatened, raising the possibility of social unrest and law-breaking behavior for survival.

**Figure 1. Extreme risks — Likelihood and impact**

	Impact	Likelihood		
		Low	Very low	Very, very low
Financial	High		Sovereign default	
	Medium	Banking crisis		
	Low		Insurance crisis	
Economic	High	Depression	Hyperinflation	
	Medium	Currency crisis		Resource scarcity
	Low			End of fiat money
Other	High		Climate change	Major war
	Medium	Euro breakup	Political crisis	Infrastructure failure
	Low	Protectionism		Killer pandemic

Key		
Likelihood	Low	Could be expected once every 10 years from current conditions
	Very low	Could be expected once every 20 years from current conditions
	Very, very low	Could be expected once every 100 years from current conditions
Impact	High	Direct and significant impact on most asset and liability values
	Medium	Direct and material impact on some asset and liability values
	Low	Direct impact on few values, variable significance

## Likelihood, Impact and Ranking

The likelihood and impact chart is updated to reflect our latest views (*Figure 1*). First, resource scarcity and infrastructure failure were added as economic risk and other risk, respectively. The disappointing economic recovery in the developed world during the past two years increases the likelihood of further economic shocks for the banking industry, justifying a one-notch leftward movement to Low. We moved sovereign default from Medium impact to High impact, reflecting our updated view on this risk. We have also moved it from an economic risk to a financial risk because default would be a financial event even though the risk of a sovereign default has both financial and economic roots.

Recent economic and political developments suggest that a breakup of the group of countries using the euro as national currency is probably more likely than it was two years ago. We incorporated this view by moving euro breakup from Very low to Low. The last change we made was to reassess the impact of a major war. The logic is that a major war could very likely have a higher impact that would result in major distortion of infrastructure in affected areas, along with other disruptions, prompting the decision to change major war to High impact and leaving infrastructure failure at Medium impact.

We use a subjective scoring system to derive a ranking of these risks, as indicated by the numbers in parentheses in the sidebar on pages 24 and 25. The change of ranking reflects the change in our view of the impact and likelihood of each individual risk. We suggest on pragmatic grounds that the ranking can be used as a priority list for considering



**Tim Hodgson**  
Specializes in investment thought leadership.  
Towers Watson, Reigate



**Carole Judd**  
Specializes in investment thought leadership.  
Towers Watson, Reigate



**Liang Yin**  
Specializes in investment thought leadership.  
Towers Watson, Reigate

**Figure 2. Association matrix**

We use the term “association” rather than “correlation” to communicate that this is a qualitative assessment of whether events are likely to occur together (with one perhaps being a minor or major cause of the other) rather than a quantitative assessment of past data. Quantitative assessment of extreme events is difficult.

<b>Depression</b>																
<b>Default</b>	H															
<b>Hyperinflation</b>		L														
<b>Banking</b>	H	H														
<b>Currency</b>	H	M	H	H												
<b>Climate</b>																
<b>Political</b>	H	H	H	M	M	M										
<b>Insurance</b>	M	M		M	L		M									
<b>Protection</b>	H	L		L	M		H									
<b>Euro</b>	H	H	H	H	H		H	L								
<b>Resource</b>			L			L	M		L							
<b>War</b>	L	L	L				H		M		H					
<b>Fiat money</b>		L	H	L	M		L							L		
<b>Infrastructure</b>			L			L		L			L		L			
<b>Pandemic</b>						L	L		L				L			
	<b>Dep</b>	<b>Def</b>	<b>Hyp</b>	<b>Bank</b>	<b>Ccy</b>	<b>Clim</b>	<b>Pol</b>	<b>Ins</b>	<b>Prot</b>	<b>Eur</b>	<b>Res</b>	<b>War</b>	<b>Fiat</b>	<b>Infra</b>	<b>Pan</b>	

**Key**

- H** High degree of association — could be causality in both directions
- M** Medium degree of association — could be causality in one direction
- L** Low degree of association — a possible contributing, rather than causal, factor
- No, or very low, association

the various risks and whether any portfolio hedging activity could, or should, be undertaken, while a purist approach to risk management should consider all risks holistically.

The association matrix also includes the two new risks (Figure 2). Causality in both directions suggests a high association between resource scarcity and major war. Similarly, we see a reasonably strong association between resource scarcity and political crisis; otherwise, resource scarcity is only a possible contributing factor to risks such as protectionism or infrastructure. Infrastructure failure is more of an independent risk only weakly associated with a few other risks. It might cause an insurance crisis if the scale of failures, and therefore insurance claims, is large enough. Infrastructure failure can also potentially cause hyperinflation since the supply of necessities might be severely distorted should it occur.

**Hedging and Asset Allocation Implication**

Extreme risks can be useful in helping to design more robust investment portfolios. One application would be in stress testing by developing scenarios, but it is also constructive to consider whether thinking about extreme risks can be incorporated within the asset allocation process.

One option would be to penalize our existing “normal” assumptions by slightly reducing expected return, or pushing up volatilities and/or correlations to reflect the impact of infrequent extreme events. However, this action is unsatisfactory. By how much should we punish the assumptions? In most cases, it will be too much, but in extreme cases, the adjustment would not be sufficient.

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 the

### Figure 3. Extreme risks — Ranking

Risk ranking\* as of June 30, 2011

Rank	Risk	Description	Possible hedge
1	Depression	Debt-deflation trap; falling growth and incomes	Globally diversified, long-dated sovereign nominal bonds
2	Sovereign default	Default by a major developed country on its debt	Country insurance (for example, CDS)
3	Hyperinflation	Extremely high inflation	Real assets like gold, globally diversified, inflation-linked bonds
4	Banking crisis	Balance sheets can't absorb another shock	Nominal sovereign bonds (medium duration)
5	Currency crisis	Extreme movement between floating rates	Gold, foreign assets
6	Climate change	Diversion of capital to mitigation uses	No general hedge
7	Political crisis	Rise in power of extremist groups	No obvious hedge
8	Insurance crisis	Insolvency within insurance sector	Nominal sovereign bonds (medium duration), short insurance equity
9	Protectionism	Reversal of movement toward free trade	No general hedge
10	Euro breakup	At least one member leaves the euro	Long Germany (hedged)
11	Resource scarcity	Depletion of resources	Depends on resource
12	Major war	A major global conflict	Long-neutral countries
13	End of fiat money	Return to a gold standard	Gold
14	Infrastructure failure	(Temporary) interruption of grid/networks	Canned food, bottled water, guns and ammunition
15	Killer pandemic	Contagious disease with very high mortality	Long pharmaceutical equities, short airline equities

\*Our subjective measure based on the impact, the risk and the degree of uncertainty in assessing the risk level

switch between the two must be successfully timed, not forgetting the need to time the switch back so we can go on harvesting returns under conducive conditions. However, dynamic switching is more easily said than done.

For those who are skeptical about market timing, the third option is a hedging overlay. We would advocate dynamic hedging (contrarian) since insurance premiums tend to rise when many people want to insure.

For example, it was possible to purchase 20-year protection against deflation at five basis points per annum in the early 2000s, while the price had risen to 35 or more basis points per annum in 2011 (and transacting in size was generally more difficult).

Of course, hedging comes with its own set of problems, as we described in the previous paper. Not all extreme risks can be hedged, and any hedge used is likely to be very imprecise. Even for risks that can be hedged, the carrying cost of a complete hedge is likely to be high and almost certain to require the use of derivatives. Analysis is needed to decide whether the counterparty would be willing and able to pay out if the bad event happened.

There are three broad hedging strategies available to us:

- **Hold cash.** To quote James Montier of Grantham, Mayo, Van Otterloo & Co., cash is “perhaps the oldest, easiest and most underrated source of tail-risk protection.” Over long historical periods, cash has held its real value through episodes of

both 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, especially in real terms in current Western markets, then this will be a difficult option. However, it is possible to view cash as having a very high option value, as some sovereign wealth funds do, with that value increasing nonlinearly with the degree of market stress experienced.

- **Derivatives.** 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 they are not exactly met, and the insurance does not pay out.
- **Hold a negatively correlated asset.** Some ideas are shown in *Figure 3*, making it clear that 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 occur.

So how should asset allocation actually adapt in recognition of extreme risks? We would suggest a prioritization exercise:

- First, worry about the events that can “kill” you — that is, permanently impair the investor’s mission. For instance, most homeowners are voluntary purchasers of home insurance despite the negative expected return, on the basis that an uninsured

“We believe the consideration of extreme risks can be useful in helping to design more robust investment portfolios.”

## The New List of 15 Extreme Risks

*For the sake of the first-time reader, we've provided a brief description of the ranking, nature and potential consequence of each risk. Risk rankings are as of June 30, 2011, and are in parentheses next to the risk.*

### Financial

**Banking crisis (4):** The risk implies that banks' balance sheets cannot withstand future developments such as a continued drop in real estate prices, increased corporate defaults, sovereign default or poor economic conditions in general.

A major banking crisis is normally associated with a flight to safety, a drying up of credit and a swift transmission to the real economy that threatens economic growth. There may be a requirement for further nationalization of banks but also a question about whether stretched government finances can afford to do so.

**Insurance crisis (8):** The risk is that the insurance industry will become insolvent because safe assets held against liabilities underperform. Inadequate capitalization of risky asset positions, or basis risk, would push insurers into insolvency. Life insurers (rather than non-life carriers) are more likely to be affected.

**Sovereign default (2):** This extreme risk is the nonpayment of interest or return of principal by a major sovereign borrower. It is more likely to occur if economic growth remains at a low level, and governments do not or cannot reduce spending, and taxes are not or cannot be increased.

There are direct and indirect consequences. Directly, the defaulting borrower benefits, and the lenders (domestic banks, pension funds and insurance companies) permanently lose that capital. Indirectly, the cost to access future financing significantly increases. While a sovereign default can set the foundation for future prosperity, the near-term consequences are negative to strongly negative for financial markets, the economy and wealth.

### Economic

**Currency crisis (5):** Technically, this extreme risk refers to the breaking of a fixed exchange rate. In a looser sense, it also means an expectation of a significant devaluation of a major currency that becomes self-fulfilling.

A currency collapse severely reduces a country's purchasing power and, hence, wealth. The direct impact on asset returns is through the currency — domestic investment in foreign assets will benefit substantially if unhedged, and investment by foreigners in domestic assets, if unhedged, will suffer very poor returns.

**Depression (1):** Depression is generally defined as a deep and protracted trough in output/GDP. The current risk of depression

remains an extreme risk because it may not be possible, given current policy settings, for governments to counteract any future drop in demand.

Depression is typically manifested by a sharp and prolonged increase in unemployment, followed by a drop in consumption, restriction of credit, and shrinking output and investment. Depressions can trigger deflation or hyperinflation (depending on the policy response).

**End of fiat money (13):** This risk reflects a collapse in confidence in the purchasing power of paper currency and the consequent return to a gold standard where the value of paper notes governments issue is linked to preset, fixed quantities of gold (or other physical commodities).

Under a gold standard, the money supply is linked solely to gold production, and central banks have little discretion to protect the economy from either a monetary shock or a real shock. Goods prices are likely to be highly unstable in the short term despite being relatively stable in the long run.

**Hyperinflation (3):** Hyperinflation is inflation that is very high or out of control, a condition in which prices increase rapidly as money loses its value. Definitions used by the media vary from a cumulative inflation rate over three years approaching 100%, to inflation exceeding 50% per month.

Hyperinflation wipes out the purchasing power of savings, provokes extreme consumption and hoarding of real assets, and causes the monetary base to flee the country and investment to cease.

**Resource scarcity (11):** The extreme risk is that one or a number of major economic inputs (for example, energy or metals) deplete before feasible (in both technological and economic terms) alternatives are put in place. It also refers to a systemic shortage of food or water.

The prospect of major resource depletion would significantly increase the cost and volatility of this particular resource, damaging business and economic output. In the most extreme case — that one major resource completely runs out — the technology based on this resource will become ineffective, and the impact on both the economy and people's lifestyles could be catastrophic.

### Other

**Climate change (6):** The extreme risk is that climate change is real and happens much faster than anyone expects or is prepared for. Capital for economically productive use is instead diverted to mitigate the effects of climate change.

Potential negative consequences are a rise in sea levels, reduced availability of drinking water, reduced agriculture output, and a danger of increased conflict within and among nations over access to food and water.

**Euro breakup (10):** The tensions between euro member countries — principally between those with current account deficits that would prefer low interest rates and a lower euro, and the rest of the members — make a breakup of the euro a possibility.

Leaving the euro would be painful, causing defaults on contracts and the redenomination of debts. Someone would experience losses. The process for determining which party bears the losses is likely to be both arbitrary and involve significant legal expenses.

**Infrastructure failure (14):** This risk is a temporary interruption of a major infrastructure network due to human behavior such as a cyber attack.

The malfunction of a major infrastructure network for a relatively long period could severely disrupt human activity and even threaten lives in critical facilities (such as hospitals). Businesses come to a halt, and prices of essential goods spike to extremes.

**Killer pandemic (15):** The risk is the emergence of a pandemic-status virus with high contagion and death rates. A major pandemic would infect a larger proportion of the population than typical flu, and have a death rate that would be a multiple higher and tend to kill those in prime health.

Assuming a significant proportion of the younger workforce died, output and consumption would fall, and government tax receipts would decline. Equity returns would suffer from both capital destruction and lower earnings; corporate bond defaults would probably rise, and sovereign yields could rise to reflect weaker government finances.

**Major war (12):** The extreme risk is a significant war that involves several major countries for a prolonged period. The invention of nuclear and biological weapons also raises the possibility that a future major war could put much of the human race at risk. Human and physical capital would be destroyed.

**Political crisis (7):** The extreme risk for democracies is that the level of social anger overwhelms reason, giving significant power to a protectionist political party. For nondemocracies, the risk is a venting of the anger in a more violent manner.

**Protectionism (9):** 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. The present concern is that short-term political necessity can override long-term economic logic, with the extreme risk of a populist backlash against free trade.

fire would be an event from which they could not financially recover. This should identify which extreme risks matter and which can be ignored. For the former, the right thing to do is to purchase insurance, while the latter can be self-insured.

- Second, investors should do the simple things:
  - Ensure the asset allocation is as diversified across as many return drivers as possible. Many institutional portfolios are heavily concentrated in equity (growth) risk.
  - Diversify within asset classes. Most pension funds are heavily exposed to domestic sovereign bonds for liability-matching purposes — extreme risk thinking would suggest reducing the quality of the match to reduce the risk concentration.
  - Create a strategic allocation to cash, along the lines suggested above, 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.

## Conclusion

The global economic environment continues to be characterized by significant imbalances and is not in good enough shape to withstand any further major shocks. This article lists a number of concerns that could disrupt recovery and long-term economic developments. It is an effort to help asset owners consider and manage their investment risk beyond the conventional VaR<sub>95</sub> level. But even with the best analysis, we will not be able to anticipate all risks. While we have a list of 15 extreme risks, by definition, they are known unknowns, and what might harm asset owners even more are the unknown unknowns. It is important to build upon our ability to adapt and learn, enhancing the resilience of the system. To quote Charles Darwin, “It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change.”

*For comments or questions, call or e-mail  
Tim Hodgson at +44 1737 284822,  
tim.hodgson@towerswatson.com;  
Carole Judd at +44 1737 274329,  
carole.judd@towerswatson.com; or  
Liang Yin at +44 1737 28 4762,  
liang.yin@towerswatson.com.*

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