Global Risks 2007

A Global Risk Network Report

In collaboration with:

- **Citigroup**
- **Marsh & McLennan Companies (MMC)**
- **Swiss Re**
- **Wharton School Risk Center**

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1. Introduction

At the core of this year's overview of risks to the global community over the next decade is a fundamental disconnect between risk and mitigation. Expert opinion suggests that levels of risk are rising in almost all of the 23 risks on which the Global Risk Network has been focused over the last year – but mechanisms in place to manage and mitigate risk at the level of businesses, governments and global governance are inadequate. The global economy has been expanding faster than at any time in history – but it remains vulnerable.

Some tactical gains have been made in specific areas of risk mitigation: despite the raised threat of terrorism, cooperation on dealing with the threat continues to improve; fears of a major pandemic outbreak have driven a major effort to upgrade our global preparedness to identify and isolate new diseases; there is a growing recognition of the need to improve access to mechanisms of risk transfer in emerging markets, to allow risks to be priced in a way that allows the potential economic growth of this century to be fully unlocked.

There has also been major improvement in the understanding of the interdependencies between global risks, the importance of taking an integrated risk management approach to major global challenges and the necessity of attempting to deal with root causes of global risks rather than reacting to the consequences.

Climate change is now seen as one of the defining challenges of the 21st century – and as a global risk with impacts far beyond the environment. Effective mitigation of climate change may ultimately have the consequence of improving resilience to oil price shocks in developed countries by moving them from hydrocarbons to alternative energy sources; ineffective mitigation of climate change will almost certainly be a factor in major interstate and civil wars within the next 50 years. The way in which climate change is dealt with at the global level will be a leading indicator of the world's capacity to manage globalization in an equitable and sustainable way.

But the tactical gains may be illusory and are certainly temporary. The manifestation of any number of global risks in the way described in the plausible scenarios in this report could quickly put those gains into reverse.

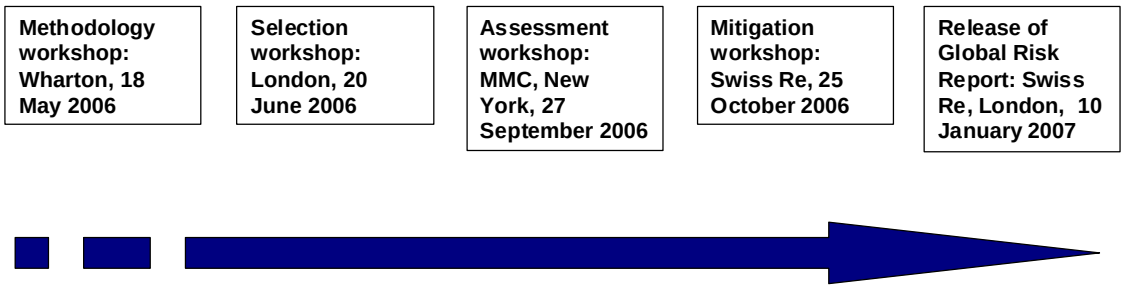
Global Risks 2007 suggests two possible institutional innovations that may help mobilize businesses and governments to approach the global risks of the next 10 years. One is the idea of a Country Risk Officer – an analogy to Chief Risk Officers in the corporate world – intended as a focal point for managing a portfolio of risk across disparate interests, setting national prioritization of risk and allowing governments to engage in the forward action needed to begin managing global risks rather than coping with them. The second is to create an avant-garde of relevant governments and companies around different global risks – "coalitions of the willing" – allowing risk mitigation to be a process of gradually-expanding alliances rather than a proposition requiring permanent consensus.

Above all, *Global Risks 2007* makes the case for the active engagement of all sections of the international community in dealing with global risks. No one group has the ability to effectively mitigate most global risks. Interdependency implies not just common vulnerability, but a shared responsibility to act.

The Global Risk Network

The aim of the Global Risk Network is to identify and assess current and emerging global risks to business and society, to study the links between them, to assess their likely effects on different regions, markets and industries, and to advance the thinking around more effective risk mitigation.

The programme was launched in 2004 by the World Economic Forum in collaboration with Merrill Lynch. In 2005, two more Strategic Partners joined the Programme: Swiss Re and MMC (Marsh & Mc Lennan Companies, Inc.) as well as an Academic Partner: the Risk Management and Decision Processes Center at the Wharton School of the University of Pennsylvania. Today, the Programme comprises six Strategic Partners: Citigroup, Nestlé, MMC, PricewaterhouseCoopers, Swiss Re and Zurich Financial Services. Three of them (Citigroup, MMC and Swiss Re), in addition to Wharton, contribute to the publication of the Global Risk Report.



2. Risk Identification

Risks are idiosyncratic – a risk to one group may present an opportunity to another. The qualification of global risks lies in their systemic nature: their impacts challenge the integrity of the system. Their consequences are harder to predict, frequently disproportionate, difficult to contain and present challenges to us all.

The key newcomers to the list for the *Global Risks 2007* report include a number of geopolitical risks which, though difficult to measure, specify and predict, were considered integral parts of the risk landscape. The risk of major interstate and civil war – often inadequately priced in markets – was one risk considered. Another was the category of failed and failing states as an underlying risk to systemic integrity. Both featured in a number of scenarios developed by the Global Risk Network.

Overall, the Global Risk Network identified 23 **core global risks** to the international community over the next 10 years. The description of these risks can be found in the annex to this report.

"Core" Global Risks

Economic • Oil price shock/energy supply interruptions • US current account deficit/fall in US$ • Chinese economic hard landing • Fiscal crises caused by demographic shift • Blow up in asset prices/excessive indebtedness **Environmental** • Climate change • Loss of freshwater services • Natural catastrophe: Tropical storms • Natural catastrophe: Earthquakes • Natural catastrophe: Inland flooding	**Geopolitical** • International terrorism • Proliferation of weapons of mass destruction (WMD) • Interstate and civil wars • Failed and failing states • Transnational crime and corruption • Retrenchment from globalization • Middle East instability **Societal** • Pandemics • Infectious diseases in the developing world • Chronic disease in the developed world • Liability regimes **Technological** • Breakdown of critical information infrastructure (CII) • Emergence of risks associated with nanotechnology

A number of risks on previous year's list were removed because they failed to meet the criteria of the revised methodology. These included regulation, failures of corporate governance, intellectual property rights, convergence of technologies, electro-magnetic fields (EMF) and pervasive computing.

Risk identification also extended to a number of "outlier" risks – those for which our understanding is currently too diffuse and the uncertainties too large to be considered core risks, but which are on the horizon of the Global Risk Network. The understanding of all global risks was refined through workshops held throughout the year and work conducted by the Global Risk Network both globally and on a regional basis.

A selection of "outlier" risk issues

Economic	**Geopolitical**
- Global economic system remains vulnerable to over-aggregation of asset classes, not differentiating sufficiently between markets. For example, an initially discrete and genuine economic problem in one market which causes market difficulties may rapidly have a contagious market which affects markets of a similar asset class elsewhere, irrespective of their real exposure to the initial economic problem. - Collapse of global trading system under pressure from regionalization and bilateralisation - Economic risks from species decline: threats to pharmaceutical development, imitations and bio-mimicry **Environmental** - Climate change-driven increase in the spread of malaria; epidemic emergence due to climate-change related population displacements - Potential for collapse of carbon markets **Technological** - Unforeseen negative human health impacts of electro-magnetic fields (EMF) as a classic outlier risk, with the nature of the potential impact	- Geopolitical ramifications of climate change: Arctic melt/Pacific Island flooding and resource conflicts; change in the nature of these conflicts and the way they are mitigated - Geopolitical risks from water/fishery conflicts - Intellectual Property Right (IPR) - related conflicts feeding geo-economic tensions and further retrenchment from globalization. - Full range of emerging geopolitical hotspots with the potential to spark or enhance tensions at the centre of the global system: China/Japan, US/China (as a result of Taiwan), Russia/US (as a result of events in Georgia) - Full range of possible state failures or major political upheavals within particular states, with major consequences well beyond their immediate region (e.g. Egypt, Nigeria, Russia) **Societal** - Human pandemic averted but a virus becomes endemic in animal populations globally, generating a near-permanent threat of mutation - Human-to-human transmission of a pandemic is treated with 'fire-blanket doses of prophylactic antivirals, encouraging a mutation

extremely hard to circumscribe - Pervasive computing is compounded by RFID technologies being widely adopted	to a version unresponsive to antivirals - Demographic trend reversal (either positively or negatively) or unexpected sharpening of current trends

Other risks from the 2006 global risk list were excluded from the 2007 list. Regulation was reassessed as a political choice rather than a global risk. Failures of corporate governance were considered to be an integral part of the risk of "retrenchment against globalization". The erosion of intellectual property rights' regimes, while presenting a considerable business risk to individual companies and industries with heavy IP value components – particularly pharmaceutical companies and entertainment companies – was viewed as being too narrow and presenting no aggregate economic loss. Nevertheless, the secondary effects of a major weakening of the global intellectual property regime could include a reduction in investment in major innovations and a consequent cost in terms of foregone economic growth.

Region@Risk

In 2006, the Global Risk Network extended its risk identification and assessment work to select regions, holding a regional risk workshop in Tokyo in June, writing a risk report on Europe (***Europe*@*Risk***) for the World Economic Forum summit in Turkey in November, and producing a briefing (***India*@*Risk***) for the India Economic Summit in the same month. Both reports are available on-line at www.weforum.org.

The purpose of this regional work has been to foster a network of individuals working on global risk issues in the different regions in which the World Economic Forum operates, to build an understanding of how global risk issues differentially impact regions and, to enhance the understanding of the regionally interconnected nature of global risks.

The ***Europe*@*Risk*** report analysed the exposure of Europe to a select number of global risks over the next 10-20 years and asked how Turkey could play a role in mitigating a number of those risks, offering a positive strategic framework for re-thinking the relationship between Turkey and the EU-25. The report identified "oil price shock/energy supply interruptions", "fiscal crises caused by demographic shift" and "interstate and civil wars" as being key global risks where Turkey offered a major mitigating role.

The ***India*@*Risk*** briefing provided an overview of six of the key global risk issues (from "climate change" to "backlash against globalization") where India faces challenges to its prosperity and security over the next 10-20 years. The regional impact of the global risk of "loss of freshwater services" emerged as a top global risk for India, with potential consequences for political and economic stability.

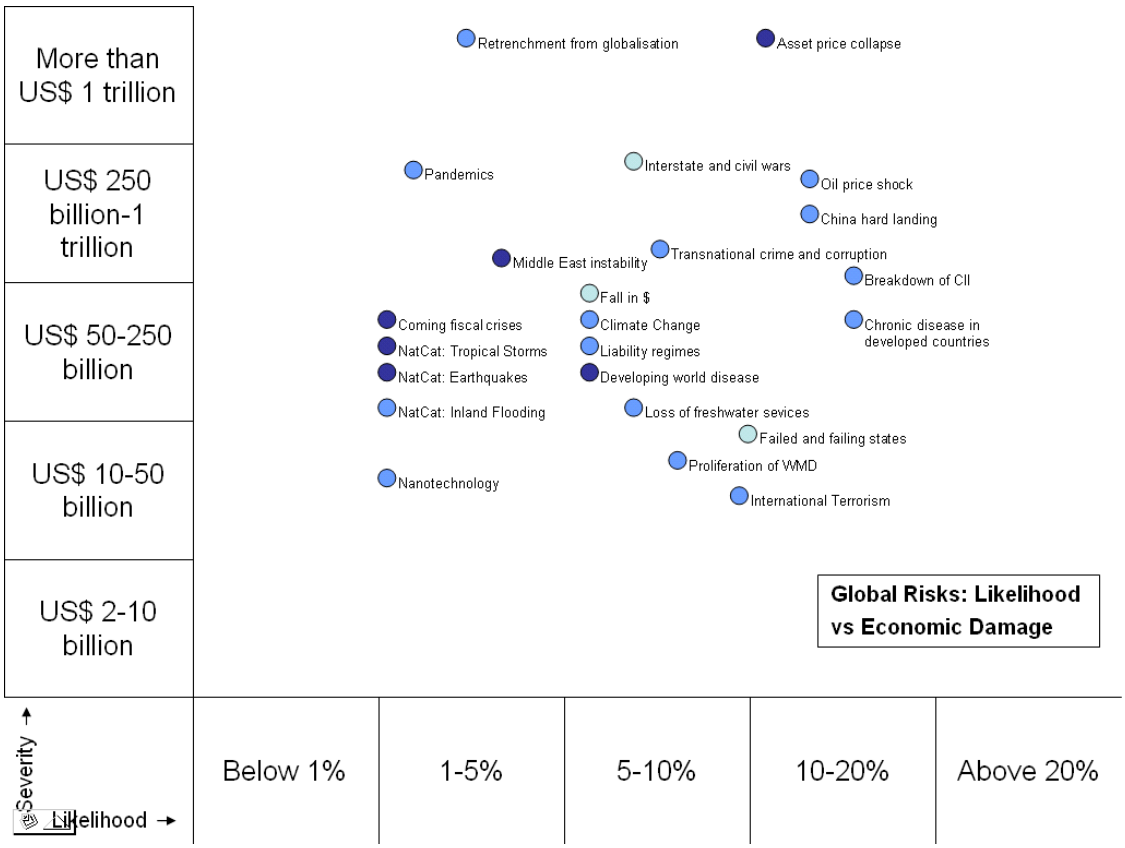
In 2007, this work on the regional level will continue to be expanded, providing for a full, global understanding of the risk environment.

3. Risk Assessment

The 23 core global risks were assessed in terms of likelihood and severity.

In addressing likelihood, actuarial principles were applied in the few cases where sufficient data existed; in most cases only qualitative assessments, based on expert opinion, were possible. In assessing severity, two indices were considered: destruction of assets/economic damage and – where applicable – human lives lost. Although some risks are inherently long term (such as climate change), and others (such as an oil-price shock) could occur in the near term, all risks were evaluated within a 10-year time frame.

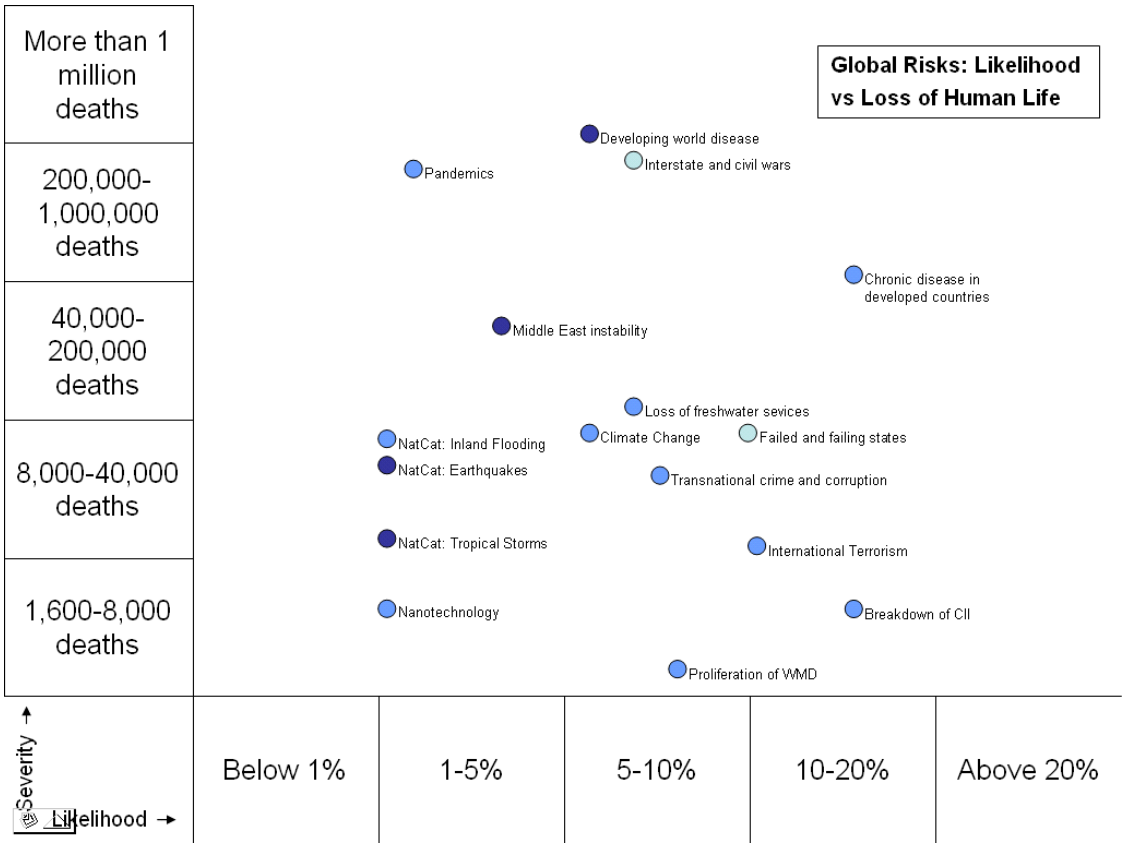
The 23 Core Global Risks: Likelihood with **Severity by Economic Loss**



Note: Likelihood was based on actuarial principles where possible. For most risks, however, qualitative assessment was used.

Increasing consensus around risk

16 Core Global Risks: Likelihood with **Severity by Number of Deaths**



Note: For nine of the core global risks, severity by number of deaths was not applicable. Likelihood was based on actuarial principles where possible. For most risks, however, qualitative assessment was used.

In addition to risk assessment in terms of likelihood and severity, the Global Risk Network developed a qualitative global risk "barometer", based on expert judgement of the outlook for global risks. This is essentially a forward-looking measure: it does not look at how the risk has played out over the last year; rather, it assesses whether the seriousness of the risk for the next 10 years has become more or less acute. For example, while 2006 saw fewer tropical storms than in 2005, expert consensus was clear that the risk trend is moving upwards, with growing agreement on the impact of climate change on severe meteorological events.

Key:

	Increased overall risk
	Stable overall risk
	Decreased overall risk
	Expert disagreement

ECONOMIC	Reason for increased, stable or decreased overall risk
Oil price shock/energy supply interruptions •	Though some estimate capacity will increase to meet demand (forecast 25% increase by 2015), the energy market remains tight and, as such, highly vulnerable to both physical and speculative shocks.
US current account deficit/fall in US$ •	Although the trade-weighted real exchange rate of the US$ has depreciated 23% since 2002, many believe this will continue, in order to limit a widening US current account deficit.
Chinese economic hard landing •	Chinese growth is both investment- and export-led. The expansion of exports may generate a backlash (particularly in the US); high investment (over 40% of GDP) has generated excess capacity and fears of potential bad debts.
Fiscal crises caused by demographic shift •	The deterioration of fiscal balances in G8 countries, combined with continuing large deficits in other large countries, renders a series of major fiscal crises possible, exacerbated by the long-term challenges of ageing and equitable healthcare provision.
Blow up in asset prices/excessive indebtedness •	House prices have doubled in most mature markets (and in some emerging markets) in real terms over the last 10 years, putting price-to-income ratios at all-time highs. Many experts fear a major correction, with differential impacts on consumption, economic growth and other asset prices.
ENVIRONMENTAL	
Climate change •	Carbon emissions are growing above trend and there are indications that feedback mechanisms, particularly increased heat-absorption caused by Arctic ice-melt, will increase the speed and scale of warming. New research argues that the increasing intensity of North Atlantic hurricanes is due to global warming.
Loss of freshwater services •	The mitigation effects of improved water-pricing have yet to have an effect; economic development and global warming have increased the risk to the sustainability of many already stressed freshwater systems worldwide, particularly in Asia.
Natural catastrophe: Tropical storms •	The increasing risk from tropical storms includes two major components. The hazard itself may be increasing as global warming drives sea surface temperatures higher. Global vulnerability to tropical storms may also be increasing as a result of coastal development.
Natural catastrophe: Earthquakes •	The threat of earthquakes, in terms of likelihood and severity, remains the same, driven by basic geophysics. Meanwhile, slight increases in the exposure of populations are matched by slight reductions in the vulnerability of assets.
Natural catastrophe: Inland flooding •	Increasing floodplain development and an expected increase in climate change-driven extreme weather events increase the risk of disruptive and costly inland flooding.
GEOPOLITICAL	
International terrorism •	The risk of future attacks has risen: according to official threat assessments in Britain, an attack is “highly likely”; the US National Intelligence Estimate report has argued the Iraq war has heightened risks, while the situations in Afghanistan, Somalia and Pakistan continue to cause concern.
Proliferation of WMD •	North Korea tested a nuclear device in 2006, Iran continued its programme, the US weakened its commitment to non-proliferation in a controversial deal with India, while some Middle East states said they would seek civilian nuclear technologies. All

	increase the risk of proliferation for 2007.
Interstate and civil wars •	Civil war took hold in Iraq in 2006 while tensions fluctuated on the Korean peninsula and in the Middle East. The International Crisis Group identified November 2006 as the worst month for conflict prevention in 40 months. The risk of any of a number of hotspots causing a major conflagration in 2007 increased.
Failed and failing states •	There is little prospect of immediate improvement in serial failed and failing states – notably Somalia, Afghanistan and Pakistan. The creation of the UN peacebuilding commission may improve mitigation in 2007 but risks are increasing.
Transnational crime and corruption •	Transnational crime and corruption remain endemic in a number of developing and developed countries, damaging state authority, economic prosperity and weakening the ability to deal with other global risks.
Retrenchment from globalization •	Progress on the Doha trade round appears distant, while failures will be difficult to reverse after expiry of Presidential negotiation authority. Populist sentiment in Europe and the US is set to increase. (See the *Europe@Risk* report.)
Middle East instability •	Overall stability is deteriorating, despite rapid growth and moves towards stability in some Gulf countries. Grand bargains to stabilize the region may be possible in 2007, but underlying problems of Islamist extremism, political succession (as in Egypt) and fragile economic structures will make the region highly volatile.
SOCIETAL	
Pandemics •	Some measures (e.g. improved research and cooperation on early warnings) have improved response capability. However, the aggregate risk is constant as uncertainty remains over the timing and nature of any outbreak.
Infectious diseases in the developing world •	Although infection rates have stabilized in some countries, infection rates for HIV and other diseases are rising in others, presenting major risks to future prosperity. India passed South Africa as the country hosting the largest population of HIV/AIDS infected people. (See the *India@Risk* briefing.)
Chronic disease in the developed world	Experts were divided on the balance between potential advances in medical science over the next 10 years and the increasing prevalence of "life-style" diseases.
Liability regimes	Experts were divided on the risks to global prosperity from liability regimes over the next 10 years: some argue liability regimes represent a legitimate policy choice, others suggest they represent a growing cost to business, yet others suggest that US-style liability regimes are unlikely to make headway in other parts of the world.
TECHNOLOGICAL	
Breakdown of critical information infrastructure (CII) •	Expert judgement suggested a balance between increasing vulnerability arising from interconnectivity and growing awareness of security issues surrounding CII with investments in resilience and spare capacity in some key infrastructure areas.
Emergence of risks associated with nanotechnology •	In the absence of any major scientific discovery, experts estimated the potential risks arising from nanotechnology were unchanged.

Generally, the picture provided by the risk barometer of expert opinion on the year-on-year assessment of global risks is one of rising risks. Expert consensus was that none of

the 23 global risk issues identified had improved since 2006. *However, experts noted that awareness on a number of risks – the first step to effective risk mitigation – had improved in a number of areas.*

A number of risks were considered to be unchanged from 2006. For one risk, earthquakes, this was due largely to the nature of the risk itself – the frequency of earthquakes is not open to human intervention. Nevertheless, the expert's overall year-on-year assessment for this risk also depended on the improvement in building standards in the developed world offsetting the increased exposure to a major earthquake by the ongoing processes of urbanisation and concentration. For other unchanged risks, the orange colour and horizontal arrow reflect a balance of advances on mitigating the risk and an increase in their likelihood and/or their severity. For example, some progress has been made on mitigating the potential effects of a pandemic outbreak, but the likelihood of such an outbreak occurring is probably rising as time passes.

A considerably greater number of risks were considered by experts to have worsened since 2006.

In some cases, such as climate change, the underlying conditions of the risk may not have themselves worsened – but there is growing consensus around the downside of the risk. In other words, as our knowledge around the risk improves, there is a realisation that the situation is worse than was thought to be the case last year. At the same time, the increasing realisation of the gravity of the situation may ultimately help the risk to be more effectively mitigated through public pressure for government action and increased scope for business opportunities.

The key risk in this context is climate change: even the central expectations of a few years ago are now considered to be potentially too low. There is growing awareness of a number of new elements which fundamentally affect how the risk develops and is managed. One such element is environmental feedback loops, such as the melting of polar ice caps, which would accelerate the pace of climate change by reducing the reflection of sunlight out of the atmosphere. Another element is the end of the masking effect of "global dimming". In the past, particulates from inefficient burning of hydrocarbons may have prevented some sunlight from reaching the earth, and thereby reduce the apparent impact of greenhouse gas emissions. As societies adopt cleaner burning technologies, the true impact of greenhouse gas emissions is rapidly revealed. The net result of both these elements is to accelerate the expected development of the risk and reduce the time-frame available to take effective mitigation action.

With respect to other risks, the conditions themselves have worsened – often for interrelated reasons. North Korea's nuclear test and Iran's likely continuation of its nuclear programme worsen the risk of proliferation of Weapons of Mass Destruction (WMD), and the eventual collapse of the nuclear non-proliferation treaty leading to a race for nuclear weapons across the Middle East and East Asia. The deteriorated security situation in Iraq – in spite of some development gains – provides a disturbing reminder of Middle East instability as the key driver of global geopolitical risk. In addition, there is a growing view that the situation in Iraq has increased the long-term risk of international terrorism.

Finally, there were a number of risk areas where expert judgement was too diverse to

produce a consensus view. For example, while the underlying conditions for chronic disease in the developed world have not radically improved there are divergent views as to how the interplay of lifestyle changes and scientific advances will affect the risk over the next 10 years.

Managing Geopolitical Risk

The first years of this century have been marked by the return of geopolitical risks to global prosperity and stability. In 2006, the deterioration of the situation in Iraq and the Middle East occupied the full attention of some governments, reducing "bandwidth" available for focus on other global risks and increasing fears of the fragmentation of the international system. Should any of the main geopolitical risks outlined here worsen considerably, the environment for business and society could be changed beyond recognition. In the scenarios below, geopolitics frequently provide the narrative and backdrop to the emergence of other global risks.

Despite their importance, however, geopolitical risks are hard to quantify in terms of likelihood and severity, and therefore difficult to price. While expert opinion suggests that geopolitical risk worsened in 2006, market expectations of volatility tended to fall, indicating a major disconnect. The concerted action of governments may help to reduce overall geopolitical risks in 2007 – improved pricing of these risks may help businesses to manage their consequences when they do occur.

The range of different trajectories along which geopolitical risks can develop – contingent on human decision-making and a range of other factors – makes their outcomes hard to predict with accuracy. For example, while the conditions for the outbreak of war may be easily identifiable – militarization, existing disputes, an inflexible attitude by the parties – the exact sequence of events which turn conditions into reality are impossible to predict. The "gambler's mentality" is unlikely to succeed.

As a result, geopolitical risk analysts normally focus on underlying trends – economic decline, environmental degradation, population density – which may provide keys to the emergence of a major event. Defence planners cope with geopolitical risk on a prudential basis – preparing for low-probability, high-severity risks (such as interstate war) which present a sovereign risk, as well as a range of more immediate challenges.

Though businesses with international exposure cannot pursue the same catch-all policy, they should look beyond discrete events and manage their risk portfolio through an appreciation of underlying dynamics. The challenge for a geopolitical risk analyst advising business is to help distinguish between events with a tactical impact and those that significantly alter underlying trends and, with them, the overall calculation of risk.

An alternative methodology for assessing Global Risks: Prediction Markets

As suggested above, quantitative assessment of some global risks can be generated reliably through models and historical data. But many risks, such as geopolitical risk, involve uncertainties which are extremely difficult to model, while others represent discontinuities about which historical data is of limited use. Yet the desire remains to put probabilities and cost estimates on these uncertain risks.

Intensive research and expert judgment is one approach often used in the markets and the public sector. But expert opinion comes with its own pitfalls – experts are not immune to the same cognitive and perceptual biases that challenge CEOs and policy makers. Indeed some suggest that experts' overconfidence in their own predictions makes them less reliable.

Another approach is to harness what James Surowiecki has called *The Wisdom of Crowds*. Surowiecki's thesis is that individual experts cannot match the predictive capacity of diverse groups of independent individuals. This insight has helped drive the popularity of prediction markets, which allow participants to buy and sell predictions about uncertain events. By aggregating, weighting, and iterating diverse opinions, such markets have consistently outperformed polls and pundits – predicting elections, and, for example, the capture of Saddam Hussein.

The Global Risk Network, in collaboration with NewsFutures, has already begun to explore the power of prediction markets. More than 500 traders have registered to 'virtually' trade their predictions about oil price spikes, avian influenza, global recession, severe weather events and a US withdrawal from Iraq. In winter 2005-2006, a trade on the potential for an oil price spike arguably came closer to predicting reality than the 1-month futures markets of the same period. The complete results are not yet in – but these markets may eventually provide unique insight into the hard-to-grasp uncertainties that make up the global risk landscape.

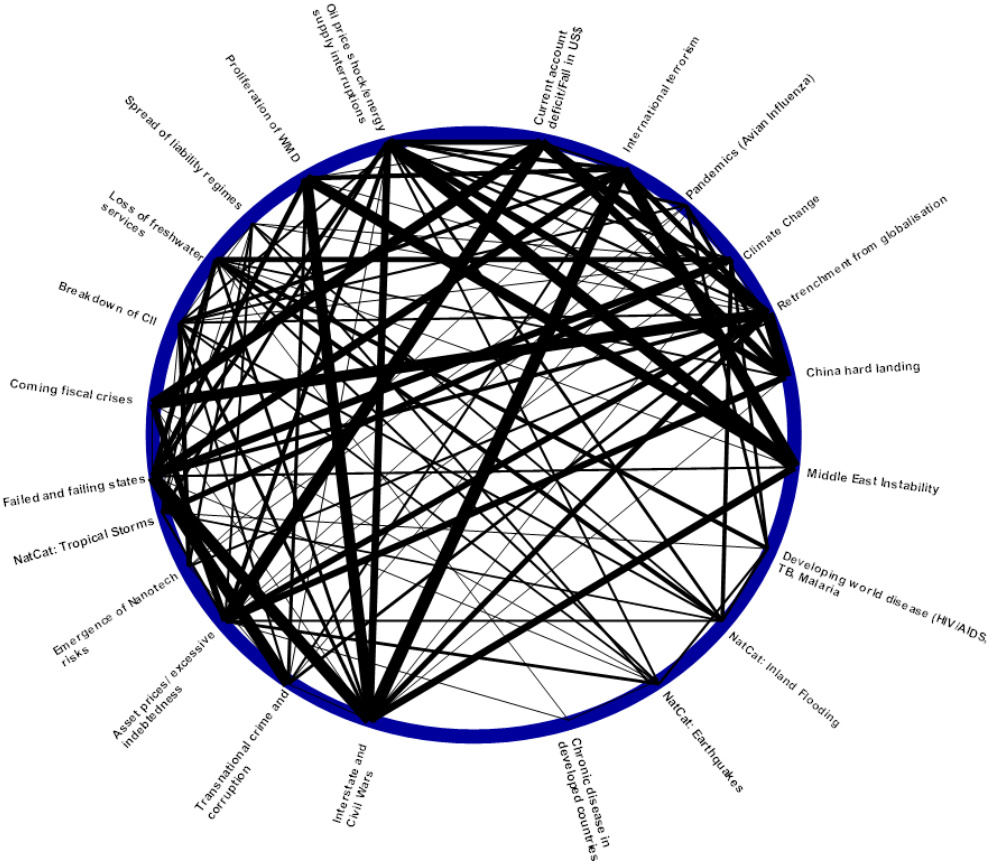
4. Scenarios

It is a central tenet of work conducted by the Global Risk Network that global risks do not manifest themselves in isolation: their drivers, triggers and consequences are interconnected. This was apparent in 2005 when the domino effects of Hurricane Katrina briefly shook the global system. More recently, the connections between two of the major issues for public policy and private enterprise – energy security and climate change – have reinforced the sense that global risks share a common lineage.

The global risk landscape has a number of prominent features – but it is the landscape as a whole rather than any one exposed feature which presents the greatest challenges for assessment and mitigation. Isolated policy responses may allow for apparent quick-wins – in the language of the global risk landscape, exposed risk peaks will have been "shaved". But failure to understand the underlying dynamics of interconnectedness may mean that those same quick-wins are overwhelmed by the unanticipated. The apparent quick-win may prove to be an inefficient use of scarce resources.

How can one best think about interconnectedness? One approach is to assess correlation. This provides a simple measure of static interconnectedness. In 2006 the Global Risk Network engaged in an ongoing survey of academics and experts to build up a picture of correlation between the 23 core risks. Many of the risk issues have multiple causes and consequences beyond the risk list itself – the matrix is not supposed to be a comprehensive explanation of causality. However, the correlation matrix portrays the strength of the macro correlations perceived by experts to exist *between* the risk issues identified and studied in this report. In the graphic below, the numerical strength of correlation between risk issues is reflected in the thickness of the lines connecting them.

The Correlation Matrix



Correlation provides an excellent overall view of links between risks, but may not capture the dynamics of interconnectedness: even when causation or consequence can be determined with confidence, the context in which risks emerge and interact as they play out may lead to different assessments of probability and impact.

In order to provide this context, the Global Risk Network looked at how key risks could play out in narrative scenarios. These scenarios do not represent “best”, “worst” or even “base” cases, nor are they predictions. Instead, they are possible, plausible global risk futures in which the challenges of interconnectedness become plain.

The scenarios below contain a number of surprises – some of them disturbing – but understanding the possible surprises ahead may allow policy-makers and business people to make decisions that will avert the worst consequences of surprise and turn risk into opportunity. While all the scenarios are plausible, none is likely to play out in precisely the way described. The short-term outlook for the global economy remains good: one Citigroup Global Capital Markets report (22 November 2006) predicts global GDP growth of 3.4% in 2007 and 3.8% in 2008. But these scenarios show how short-term central expectations may plausibly deteriorate.

One of the key lessons that emerged from all the risk scenarios developed by the Global Risk Network was the absolute centrality of cooperation between the United States and China in dealing with a number of major global risks – from mitigating climate change, to managing pandemics. Without the full engagement of both the US and China, global

risks will be extremely difficult to manage successfully. The accelerating shift in influence, power and prosperity to the countries of Asia represents a generational opportunity to rethink governance and creates the necessity to forge common approaches to global risks.

Global Risk Scenario A: *Pandemic and Its Discontents*

The following scenario illustrates the impacts on business, the financial system and political and economic conditions that could follow from the emergence of a new pandemic. It also illustrates the amplifying role played by "infodemics", where the rapid spread of inaccurate or incomplete information can amplify the effects of the core risk event.

In January 2008, reports of a new virus emerge in Asia. Its properties are not well understood, but its roots may lie in the high viral loads present in the heavily vaccinated Asian chicken population.

From the outset, speculation about the virus spreads faster than essential facts. Expert commentators suggest the virus is more deadly than SARS, while governmental data is widely questioned. Fear spreads ahead of the disease, and some neighbouring countries close their borders immediately.

By February 2008, the disease has claimed fewer than 50 lives. Before the end of the month, Australia and Germany report infections carried out of Bangkok International Airport. Many passenger aircraft travelling to South-East Asia are grounded. But the effect on air freight companies is worse: a number are forced to declare *force majeure* on significant contracts, pushing them towards bankruptcy.

The knock-on effects on just-in-time inventories appear by the beginning of March, with longshoremen refusing to unload cargoes from infected countries. The oil price crashes.

In late February, a large hedge fund fails due to sudden asset devaluations. Herd behaviour causes global liquidity to dry up. Neither the G8 nor the G20 is able to coordinate a response. Central banks inject liquidity ad hoc, creating inflationary risks. As black box models fail to adjust, financial contagion continues.

By late March, there are several hundred confirmed deaths outside South-East Asia, but the virus remains poorly understood. Conspiracy theories abound, with ethnic minorities a frequent target.

By early June consensus emerges that the virus has been spreading for a year. Yet characterization of the virus continues to move slowly and the ineffectiveness of existing anti-virals has led to a containment crisis. Liability fears among pharmaceutical companies threaten eventual vaccine production, while governments fail to credibly signal exemptions. A scaled-up response looks unlikely.

In some Asian countries, widespread discontent at the authorities' response to the pandemic – particularly in inland regions – leads to the centralization and militarization of government services. In developed democracies, armies become key emergency service providers.

Failed and failing states, particularly Myanmar, Nepal and Pakistan, end up completely isolated and deteriorate quickly, although for different reasons. In Myanmar, different factions scramble to maintain their relative positions. In Pakistan, rumours of inequitable mobilization of government resources cause tensions between central and border regions and between the Sunni majority and Shiite minority. In Nepal, the country is shut from all sides, affecting the provision of stabilization assistance and sharpening political divisions.

Globally, increased fear of cross-border movement and trade feed an emerging backlash against globalization, which in turn compounds the hit on global demand.

By November 2008 the disease is a full-blown pandemic, with one million deaths worldwide. Centralized containment measures are of limited efficacy, but private and decentralized efforts help slow the spread. By January 2009, a partially effective vaccine is produced, with distribution from March. However, internationally, there are questions of who should distribute the vaccine, to whom and at what cost. Domestically, active militaries step into a crisis-management role helping to distribute vaccines.

By summer 2009, vaccination and natural immunity have stemmed the spread of the disease. Globally, normalcy returns, though increased militarism and authoritarian tendencies have reshaped global geopolitics.

Global Risk Scenario B: *Out of the Global Warming Frying Pan (and Into the Fiscal Fire)*

Information asymmetry also plays a key role in this scenario, which illustrates the knock-on effects of a major shift in risk perception: namely, that climate change has arrived.

Events in 2007 trigger an inflection point in global concern over the consequences of climate change.

First, massive inland flooding in South Asia resulting from a late monsoon leads to crop failure, as well as mass migrations. Tensions rise on the Bangladesh-India border as thousands flee humanitarian disaster. In the Americas, oil supply is still disrupted from 2007 tropical storms; an unprecedented cold snap in the north-east of the US leads to a spike in heating-fuel prices as domestic and local supplies are exhausted. Finally, figures released in December 2007 show an unprecedented spike in the global temperature of 1.5 degrees Celsius for the year as a whole.

China's remarkable story of 28 years of economic growth – a Citigroup Global Capital Markets report (22 November 2006) predicts real GDP growth of 9.8% in 2007 and 10.7% in 2008 – is disturbed by awareness of environmental degradation and inequality between "many Chinas". Some 150 million surplus rural workers drift between villages and cities by 2008, with many subsisting through part-time, low-paying jobs. This dislocation is masked by unreliable official figures, but eventually causes widespread civil unrest. In part due to the Beijing Olympics, the government is initially unable to calm demonstrations resulting from viral text-message campaigns. The protests seize the mood of global discontent and speak loudly on the issue of environmental degradation.

In North America, public concern over climate change leapfrogs scientific consensus. High oil prices cause a pull back from US asset markets, bursting that country's "housing bubble". Popular discontent results in calls for radical action.

In the United States, legislators follow California's populist lead, establishing a national carbon trading scheme and creating industry incentives for conservation and alternative energy. In late 2008, the US administration releases a white paper entitled "From Addiction to Oil, to Blessed by Biofuel", signalling an enhanced focus in US energy policy on biofuels, particularly relevant to farming communities in the American Mid-West. The white paper wins political support both from "hawks" seeking US energy independence and those fearing climate change.

This policy response has the unintended consequence of setting up acute competition for productive land, between food, fuel, forests and fibre, with increased carbon sequestration and mining activities competing at the margin. Prices rise for agricultural commodities and land.

Meanwhile, China concludes the only practical option for the country's future energy needs is nuclear, with coal-fired electricity as a bridging source. The government announces large-scale infrastructure spending and concludes negotiations with major suppliers of uranium.

While supply constraints and elevated demand keep oil prices high over 2007 to 2010, other developing countries follow China's lead, and demand the right to sovereign control of the nuclear fuel cycle. This puts increasing pressure on the international nuclear non-proliferation regime, causing it to reach a tipping point. The continued failure of the international community to halt Iran's nuclear programme leads that country to proclaim successful enrichment in early 2015.

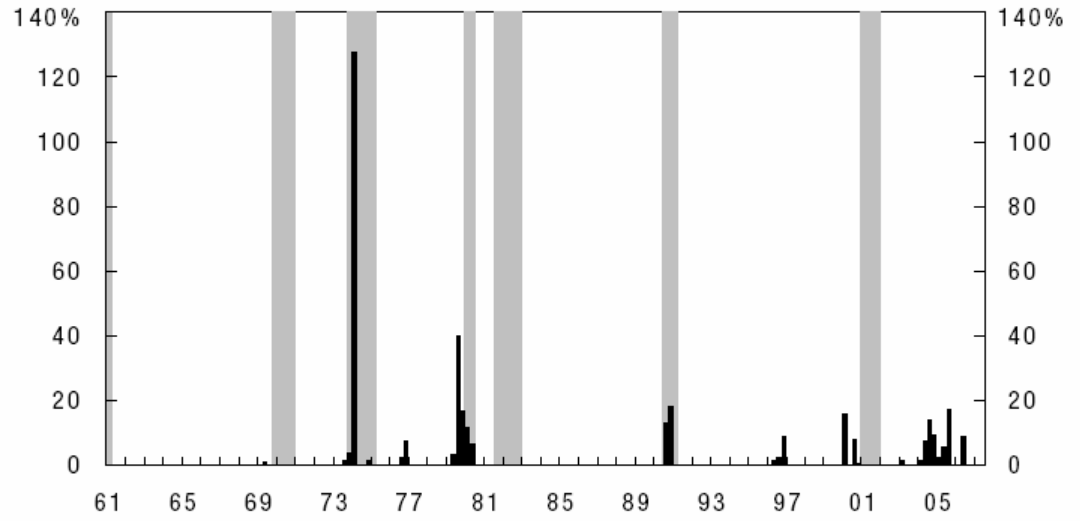
Global concerns cause risk premiums to rise, and equities to slide. In North America and Europe, retirement funds are impacted. Governments are put under pressure to increase state financial support, causing fiscal positions to worsen, particularly in Europe. At the same time, the bursting of the US housing bubble and declines in equity markets cause private savings in major developed economies to rise – beginning a process of correcting long-standing global economic imbalances.

Global Risk Scenario C: *Oil Shock and Its Consequences*

This scenario also illustrates the ways in which policy responses to a single shock can either create opportunities for change or facilitate a chain reaction of global risks.

In early 2008, terrorists attack multiple tankers in the Malacca Straits, sparking a major supply-side oil price shock. The initial shock drives oil above US$ 150 per barrel. Producing countries, acting in concert, choose to "close the tap"; a global slowdown does not reduce demand for oil products enough to counteract the supply shock. The short-term price elasticity of demand for oil proves itself to be low.

Figure 16. Oil Shocks (Using Hamilton Filter), 1961-3Q 06



Notes: The filter measures an oil shock as the greater of zero or the percent change of the inflation-adjusted US$ oil price over the peak price of the previous three years. Shaded areas are U.S. recessions.
Sources: BLS, NBER, and *The Wall Street Journal*.

A secondary reaction of oil-producing countries is to match economic weight with a permanent increase in international political weight. Oil-producing countries aim to achieve this by setting up parallel alliances known collectively as ChavPec. The operational mode of these alliances is the expansion of development assistance from oil producers to politically sympathetic and economically vulnerable countries, in return for political support. Rather than windfall gains from high hydrocarbon prices flowing to the developed world, the windfalls generate political goodwill among developing countries.

Continuing with the scenario, the collapse of Pakistan is averted in mid-2008 by redirected oil revenues, resulting in a geopolitical realignment with Arab OPEC nations. Other blocs, similarly structured around commodity exporters, emerge in other parts of the world: between Venezuela, Bolivia and poor Latin American countries; between Russia and former Soviet republics with major energy deficits (notably Uzbekistan, Georgia and Armenia); between African commodity exporters and their neighbours. While some alignments cause concern in the West, they also help to avert state failure.

But the emergence of the ChavPec block does not go unanswered.

A countervailing OECD bloc emerges. The Malacca events cause an immediate slowdown, but the 2008 slowdown quickly turns into a recession in 2009 as OECD governments and central banks have used up their ability to inject liquidity. The recession is worse in the US than elsewhere. In the US, falling asset prices drive down consumption while the unwinding of long-term current account imbalances to which the US is particularly exposed causes a deep recession. In Japan, while higher energy prices help Japan escape deflation, growth is destroyed by the decline in European and American demand for finished goods.

Figure 15. Global — Alternative Scenarios for Financial Markets

	Short-Term Interest Rates	Long-Term Interest Rates	Equities (Changes)	Currency (Trade-Weighted Basis) Changes	Investment Grade Corporate Credit Spreads
Scenario 3: Stress Case (Oil Shock), 3-Month Horizon					
United States	5.25	4.75	-15%	-3%	+40bp
Japan	0.25	1.50	-15%	-3%	+20bp
Euro Area	3.50	4.50	-15%	+5%	+40bp
UK	5.50	5.00	-12%	+3%	+40bp
Australia	6.25	5.75	+5%	+0%	+30bp

Source: Citigroup.

Source: Citigroup Global Capital Markets report, 22 November 2006

[Over a 3-month time horizon of oil prices above US$ 100, equities in the United States and other markets are expected to decline by over 10%.]

In the US, Europe and Japan, events are marked by retrenchment from globalization in general, characterized by populism (in Europe and the United States), regionalism (in the emerging OECD bloc as a whole) and militarism (in the US and Japan).

But the most problematic response to high oil prices comes from China, which experiences its own economic hard landing in 2009, primarily due to the collapse in OECD consumption. The speed with which longstanding global imbalances unwind affects China more than OECD bloc countries. But the major consequence is political. China's leadership emphasizes militarism in an effort to consolidate power. Tensions over Taiwan are inflamed. An emboldened military builds up power projection capacities from a relatively low base and turns its attentions south, with an eventual aspiration to control the sea lanes and approaches to major choke-points (including the Malacca Straits). India is isolated by these events, failing to find its place in any of the emerging major blocs. Over a period of time, tensions with Pakistan – particularly after Pakistan's realignment with Arab OPEC countries – worsen, leading to heightened fears of a nuclear exchange over Kashmir.

The final major casualty of the oil price shock is the prospect for collective action to mitigate climate change. Though the high oil price causes the rate of increase of oil consumption to fall, its major impact is to delegitimize proposals for a global carbon tax. The effect of higher oil prices on alternative energy substitutes only plays out in a 10-year time-horizon. In the short to medium term, the chief substitute for oil – where this is possible – is an increase in the consumption of coal. The fracturing of the international community means that a framework that would make carbon capture and storage attractive politically or economically does not emerge.

Global Risk Scenario D: *Gathering Perfect Storm*

Scenarios must be plausible – but they need not be balanced to provide useful insights. In sketching the gathering perfect storm, the following scenario illustrates just how many signals lie already on the horizon, and just how many important decisions the world must

take in the coming years. The scenario begins at the end: looking backward from the vantage point of the World Economic Forum's Annual Meeting in Davos, 2017.

A speech is made at Davos 2017 to the assembled company, a smaller group than in some previous years and gathering under grim circumstances. The keynote speaker welcomes the delegates of all seven Chinese states, including those of Taiwan/Fujian which have merged. The scene is set by an overview of how the world has changed over the last ten years:

"The group of countries gathering here today is somewhat different to that of 10 years ago – and we are a different group of delegates: wiser, perhaps, than the delegates of this same conference in 2007. That year was the last in a period from 1990 of extraordinarily benign economic and geopolitical conditions. It was felt then that these conditions were normal – our experience since then has proved otherwise.

What has changed over the last 10 years?

We have lived through China's hard economic landing in late 2007, the internal political divisions which ensued from that slow-down and, ultimately, the civil war and slow break-up of what we then knew as China into seven successor states present here. We have lived through the global economic recession which the world suffered as a consequence of those events. We have lived through, in particular, the devastation of African commodity exporters as a result of the abrupt end of the early twenty-first century boom.

American and European protectorates have emerged in the West Middle East and the East Middle East respectively. The proximate cause of this, you may remember, was the abortive American attacks on Iran in 2007 which failed to destroy that country's growing nuclear capabilities but which generated widespread anger against the US in the Arab and Muslim worlds. You may remember the fall of President Musharraf, brought down by public demonstrations against the US intervention, and the catastrophic decline in the Indian stock exchange which resulted – as the world prepared itself for a major interstate war between the two powers of the sub-continent.

We have seen the troubling decline of the world's ability to feed itself, particularly, as a result of the near-exhaustion of fish stocks, in coastal areas.

We have seen climate change – once thought a scientific theory, now experienced as a fact – accelerate as a result of feedback loops caused by the melting of the polar ice cap (and its subsequent failure to reflect sunlight back, out of the atmosphere) and as a result of the melting of the Siberian tundra and the beginning of the release of methane into our ever-more-fragile global ecosystem.

We have seen the rise of the "New Russia" – which many in the West have experienced as not dissimilar to the old Russia – trying to stabilise its own region, and creating a new imperialism over vast parts of the Eurasian heartland.

We have seen Japan's savings – a nest-egg for its rapidly ageing population – undermined by the Chinese civil war, compounding an already serious fiscal problem experienced in a lesser form in Europe and also in the US, in spite of its more rapidly growing population.

The defining moment for Europe, of course, came in 2012 with the terrorist explosion of a small and crude nuclear device in Rotterdam, killing thousands and, for a time, closing that city to international trade and shutting a large portion of Europe's container trade.

And behind all these events the influenza pandemic of 2008-2009 which the world was unprepared for as a result of the global economic slowdown and a decreasing will to collective action. As recently as 2006 the issue of a pandemic was at the top of the international agenda; by the time a pandemic broke in 2008-2009 the momentum created in 2006 had been allowed to wane.

What can we learn from the last 10 years?

Human society has been resilient – and society has managed to seize opportunity from even these events. There has not – yet – been a systemic failure of the global system which ends civilisation as we know it.

But we could have done much better. How many of the warning signs for the events of the last 10 years were evident already at the end of 2006? It is my contention that, while the chain of risks that occurred would have been almost impossible to predict in advance, decisions could have been made by politicians, administrators and businessmen to avert some of these risk events. Different choices on issues of public health, management of global imbalances, mitigation of climate change or the energy equation – as well as building greater systemic resilience and redundancy could have led to a much brighter picture for this year's Davos.

We are not victims of our destiny, we are – however unwittingly – authors of it.

The clouds were gathering in 2006. It is our own failures to deal with global risks which turned the clouds into the perfect storm".

5. Understanding the Nature of Global Risks

This section of the report provides a brief exploration of three fundamental aspects of global risks: interdependency, heuristic biases and policy mistakes. The first provides an insight into the nature of interdependency and provides an example of how interdependency affects the way in which we manage and mitigate global risks. The second reflects a human approach to risk in general. Humans operate with incomplete information through the use of heuristics. The third, often connected to the second, explores how policy, often intended to mitigate risk, can actually exacerbate it.

Why Interdependence Matters for Security

A major challenge for policy-makers is how to encourage firms to invest in risk-reducing measures in a world where there are growing interdependencies between different parts of the system. Since 9/11 there has been a focus by researchers and practitioners on strategies for dealing with this issue under the heading of interdependent security (IDS). An interdependent security setting is one in which each individual or firm that is part of an interconnected system must decide independently whether to adopt protective strategies that mitigate future losses. These measures can reduce the risk of a direct loss to a country, firm or individual, but there is still some chance of suffering damage from others who do not take similar actions.

The economic incentive of a decision-maker to invest in protective actions depends on whether others are expected to follow suit. The fact that the risk is often determined in part by the behaviour of others gives a complex structure to the incentives that individuals or firms face to reduce or invest in risk mitigation measures.

In many interdependent security problems, if one actor believes others will not invest in security, the incentive to do so is reduced. The end result may be that no one invests in protection, although all would have been better off if all had incurred the cost of a protection strategy. On the other hand, should each decision-maker believe others will also undertake mitigation measures, the optimal strategy will be to do the same.

Scenarios B and C, above, illustrate the point. In both cases there is a need for individual countries to undertake actions which have a potential immediate cost to its own businesses, but long-term benefits to the global community as a whole. For example, were one country to choose to institute a carbon tax on its own firms there might be a beneficial effect in terms of reduced global warming – though the production of carbon may simply be shifted to other geographies – but it will have a negative short-run consequence for the affected firms whose operations will have been made more costly compared to competitors not subject to the tax. There is no economic incentive for a country to adopt such measures unless they know that others will follow suit. This raises the need for well-enforced treaties, such as a global carbon tax or other emissions-reducing measures.

Setting policy under conditions of interdependency: Reducing the risk of power outages

Consider a utility that is part of an integrated system – the power grid – and wants to determine whether to invest in additional capacity or security measures (such as taking care of growing vegetation near distribution lines) to reduce the chance that it will cause a power outage. In any highly interdependent system, such as the power grid, there is a systemic tendency to underinvest in reliability. A consequence of interdependency is that a part of the cost of a failure is passed on to competitors and their customers.

Since 2002 several outages in individual European countries (France, Italy, Germany, Switzerland) have had cross-border impacts. An agreement between different European grid operators already exists, defining who should provide back-up power when an outage in one country risks undermining the stability of the European transmission system as a whole. Although this agreement was able to avoid larger damage, it could not prevent the spread of the problem.

There are a number of alternative approaches. One is based in the provision of the service as a right for the customer, under which a utility would be held responsible for the full costs of a service failure, wherever it occurs. This is only possible, however, if the grid is set up in such a way that additional costs for providing transmission services are not directly passed on to customers. A second approach, more explicitly based in regulation, is to mandate minimum reliability standards with monitoring and serious penalties for non-compliance.

The first approach provides a clear incentive on the part of service providers to avoid failures. But it is only a valid option when accompanied by oversight. If customers are made to bear the cost, the distribution of incentives would be asymmetric. The transaction expenses (information, proving responsibility, legal fees) would be prohibitive for individual customers to seek to recover outage costs. The second seeks to prevent them through explicit regulatory action.

Heuristics

The world is increasingly complex and uncertain. With imperfect information, humans cannot make fully-informed decisions; contrary to neo-classical theory, humans do not make fully rational decisions either. Our decisions frequently depend on approximations of the world around us – short cuts that allow quick decisions by resorting to learned behaviours. These short cuts and “rule-of-thumb” practices are known as heuristics, derived from the Greek word “to find”.

To a large extent, the existence of heuristics stems from the fact that human brains have evolved to specialize in rapid decision-making at the expense of processing complexity. In our original condition, survival depended upon the rapid appreciation of threat and an effective response. Heuristics are often useful, making decisions quicker and easier. But they can also lead to inaccurate judgements, particularly in risk perception.

There are approximately 80 specific heuristic biases that distort our ability to assess risk

effectively. Most are not independent of one another, but exacerbate the effects of others. The use of highly diversified networks can help overcome a number of biases: interpreting a story of events through the lens of superficially similar accounts (availability), focusing on instances which seem to confirm our initial assumptions rather than those that question them (confirmation bias), overestimating our own abilities to assess (overconfidence) and clinging mentally to facts or figures heard in a particular context (anchoring).

Policy Errors in Risk Management

Historically, public policy in financial markets has both mitigated and exacerbated risk. Global risks, difficult to understand and dependent on a range of interconnected factors, are particularly susceptible to policy errors, whether on the part of governments, regulators or central banks.

In some cases, policy has dampened the effects of the market and thereby reduced volatility – automatic stabilizers in welfare economies, for example, have helped to flatten economic cycles. In others, however, policy has seriously exacerbated risk: most initial government responses to the stock-market crash of 1929 – combining mercantilism with a classical approach to wages and prices – sharpened the consequences of the event rather than mitigated them. More recently, errors of regulatory or monetary policy have either reduced the ability of the market to mitigate risk, or exacerbated risks within the market itself.

Policy errors are generally obvious in retrospect but rarely obvious at the time – decisions made by governments and regulators depend on judgement, experience, incomplete information and the balancing of alternative paths of action. However, the awareness of potential policy mistakes may offer the best mitigation strategy for avoiding errors in the future.

A frequent problem in insurance is over-regulation. The example of car insurance in the US state of New Jersey is instructive, where policy intended to improve insurability ended up reducing it. The mandatory state policy that insurers must take “all-comers”, coupled with severe restrictions on rates, produced the result that insurers were unable to price premiums based on real risk levels: risky drivers paid less and safe drivers paid more than warranted by true actuarial calculations of risk. Strong growth in the costs of claims was compounded by a no-fault system in the awarding of claims. The result was the departure of large insurers from the state, and a rise in insurance costs to the highest in the country. More recently, adjustments in state policy have encouraged some insurers to return, but not all problems have been resolved.

In banking, the US Savings and Loan (S&L) crisis of the late 1980s and early 1990s provides a recent example of a series of policy errors by government and regulators in their approach to the financial services’ industry. Deregulation of the S&L sector, not matched by any increase in monitoring of the system, eventually led to the collapse of a large number of banking institutions, costing taxpayers over $100 billion. Deregulation allowed banks to offer any level of interest rate to depositors to attract funds, with the result that these interest rates tended to rise. At the same time, competitive pressures led to the lowering of the rates charged by the S&L institutions to borrowers. The result was that the financial viability of the S&L institutions was reduced, making them vulnerable to changes in market conditions. In addition to these policy errors in the

functioning of the system before the collapse, the regulators monitoring the S&L sector were insufficiently staffed or focused on this problem as it emerged. Consequently, many banks became insolvent before they were closed. Since the federal government insured deposits through the Federal Deposit Insurance Corporation up to a value of $100,000, taxpayers ended up bearing a large share of the cost of these policy errors.

Finally, in monetary policy, the 1997 Asian financial crisis provides an illustration of policy error leading to systemic risk in the financial markets. Though many Asian countries were experiencing a variety of internal regulatory issues – including management of solvency problems in the banking sector – the trigger for the systemic crisis was the collapse of the Thai baht. Thai monetary policy kept the baht closely linked to the US dollar. However, when the trade balance deteriorated and imports greatly outweighed exports, the Thai authorities stuck to their strong baht policy. The policy ultimately proved unsustainable: the baht depreciated sharply, revealing a large amount of debt payable in US dollars and an inability by corporations and banks to pay off this debt from their baht-denominated income. Today, the baht floats freely, which has greatly alleviated the risk of systemic failure.

Understanding interdependency: Airline Security

An airline must determine whether it wants to invest in baggage security, knowing that even if it takes this action, it may face a security risk from a dangerous bag loaded onto its plane by another airline. It faces this risk unless it inspects all transferred bags. This is more than a theoretical point. In 1988 terrorists checked a bag containing a bomb in Malta on Malta Airlines, which had minimal security procedures. The bag was transferred in Frankfurt to a Pan Am feeder line, and then loaded onto Pan Am 103 in London's Heathrow Airport. The bomb was designed to explode above 28,000 feet, a height normally first attained on this route over the Atlantic Ocean. Thus, in this case, the terrorists deliberately exploited the widely varying security procedures across the airlines. This problem is common to other transportation modes, where there are interconnections between nodes in the network. Following 9/11 baggage security measures were instituted in all airports to attempt to address this weak link problem and take the responsibility out of the hands of individual airlines.

The issue is hardly resolved, however. Most airline security experts concede that the greatest current threat to aircraft and the air-travelling public is from unaccompanied freight. While there are certainly risk-mitigation strategies in place tied to identification of “known” and therefore presumptively safe air-forwarders, the system is not watertight. To bring the safety of the system up a notch would be very expensive in its own right, and carry considerable costs for the businesses which rely on air shipment. The disincentives to individual carriers to improve their procedures, therefore, absent concerted and well-policed multilateral efforts, are very considerable. We are probably one air disaster away from a major political scandal over gaps in the current system, to be quickly followed by a sweeping and hugely expensive government-mandated and enforced reform of the system. Incremental improvements by the airlines themselves, which might forestall such sweeping measures, are nonetheless unlikely.

Managing interdependency: Supply-chain management

The effects of supply-chain disruptions (whether from natural disasters, terrorism, or other unexpected events) on the profitability of supply-chain participants are now recognized as being potentially catastrophic. For example, shipping delays and other supply-chain disruptions during the 1990s showed that companies experiencing such disruptions underperformed their peers significantly in stock as well as operating performance. In recent years the degree of supply-chain interdependence has increased markedly, largely as a result of greater globalisation and outsourcing.

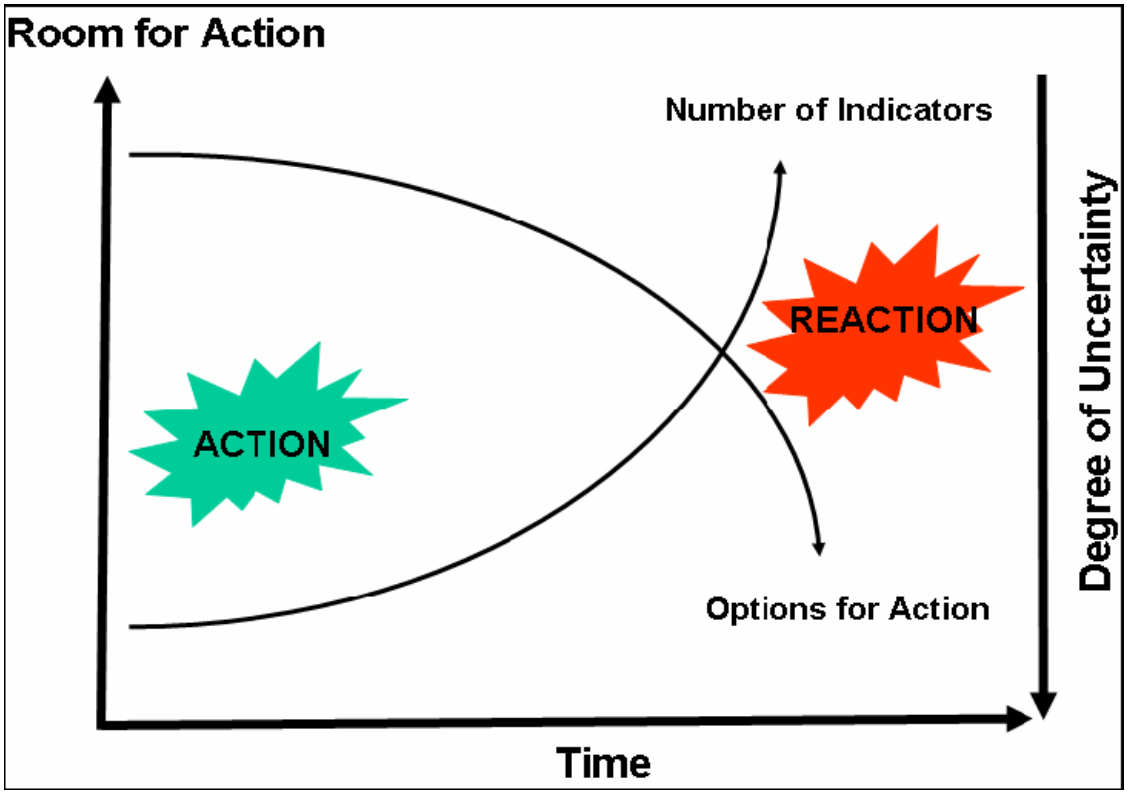
Supply-chain risk management has begun to evolve in order to meet the new demands faced. This includes moving beyond a traditional 'tactical' role (for instance in determining comfort levels in sourcing from individual suppliers) to a more strategic role including assessing (and indeed optimising) the overall risk-adjusted performance of the end-to-end supply-chain. New approaches have been developed to assess the organisation's overall supply-chain risk exposure and its susceptibility to both individual and multi-supplier failures (be they physical or financial in nature).

For example, leading manufacturing firms are now capable of determining the impact of failures at individual supply-chain nodes on their downstream dependent cash-flows. They do so by harnessing the wealth of untapped supplier information captured within their corporate MIS systems. Data sharing is also being deployed in order to derive a more complete picture of aggregate levels of supplier risk exposures. And in certain cases, predictive modelling is being deployed in order to assess the likelihood of individual/combined supplier failures occurring such that these can be addressed ex-ante. To do so requires the application of analytical techniques similar to those developed by credit rating firms, but with the application of these techniques going significantly beyond supplier financial risk scoring.

5. Risk Mitigation

The aim of risk identification and risk assessment is to provide the tools to mitigate exposure to global risk. But the step from the assessment of individual global risks to the mitigation of global risks under conditions of uncertainty, interdependency and competing interests is far from simple.

Mitigation involves a constant balance between action and reaction, between preventing a risk from occurring and dealing with its consequences when it does, between acting rashly and acting too late.



Source: Crisis and Risk Network, Swiss Federal Institute for Technology

[As time progresses, the information surrounding a given risk event may increase. But as it does, the options available for effective mitigation are bound to reduce. Risk mitigation – as with risk itself – involves degrees of uncertainty. Taking proactive mitigation policies implies operating under considerable uncertainty, with incomplete indicators.]

Prioritizing Risk

Resources for risk mitigation are necessarily limited; prioritization among risks is a necessary step for deciding how mitigation resources should best be spent.

The normal basis for prioritization is, firstly, an assessment of the likelihood of the risk occurring and the severity of the consequences of the risk occurring. These assessments are necessarily idiosyncratic and distorted by a range of heuristics – for example, perceived likelihood is affected by "recency" and "availability" biases while severity depends on "vividness" and perceived vulnerability. A second element to prioritization is values – the different values of an organization may determine its perception of vulnerability, as well as its perception of responsibility for mitigation. A third and final element is openness to mitigation – risks where there are clear strategies for mitigation will tend to be mitigated before those where strategies are more diffuse, even if the assessment of likelihood and severity is less acute.

At the global level, these key elements of risk mitigation are problematic. First, the potential consequences of combinations of risks affect all organizations, even if global risks are often perceived by individual organizations and countries as exogenous. Second, global risks may produce consequences outside the central expectations of risk managers – they represent low-probability, high-impact events which cannot necessarily be well understood through classic cost-benefit analysis. Third, global risks (such as climate change) may emerge over a multi-decade time-frame, making it necessary to compare mitigation over different generations to ensure equity. Fourth, interconnections between global risks complicate prioritization – looking at global risks in isolation may increase the perceived costs of mitigation: as this report argues, interdependencies are the key factor in the global risk environment. Finally, mitigating global risks often requires the cooperation of different groups – issues of how to manage collective action impact heavily on how individual and global risk mitigation priorities can be successfully aligned (the "tragedy of the commons"). Most global risks are not open to effective mitigation by any individual organization.

The *Stern Review on the Economics of Climate Change* offers one approach to managing risk prioritization on the multi-decade and global scale, suggesting a low discount rate for calculating the net present value of future costs from not acting to mitigate climate change. It is an approach that aims to get beyond national vulnerabilities to assess the systemic costs. An alternative approach, explicitly stating a limitation on available mitigation resources, is that undertaken by the Copenhagen Consensus project. Risk prioritization at the global level is a major task – but a necessary prerequisite to efficient mitigation.

The approach taken to mitigate an individual global risk will depend on prioritization, resources and understanding. Some risks can effectively be mitigated with relatively few resources by changing individual mindsets and altering behaviours – others require strong institutional processes and actions. What is common to the mitigation of all global risks is that they require alignment on priorities, common understanding and common efforts to overcome problems of collective action.

One approach involves acting to prevent the manifestation of a specific risk. The

advantage of “upstream mitigation”, if successful, is that it allows the disruption of the risk event itself to be avoided. However, this assumes a degree of certainty about the manifestation of the risk, and the expectation that it can be managed in isolation. The scenarios in this report suggest that interdependency between global risks is hard to manage in this way. An alternative is to attempt to understand nodes of interconnectedness between global risks, and focus mitigation efforts on them.

A final approach is to improve resilience, allowing the system to cope with a range of unexpected manifestations. Such “downstream mitigation” recognizes that not all events can be predicted and prevented.

Why are organizations not more proactive in mitigating risk?

The following is a list of common reactions to risk, which prevent a proactive approach to risk mitigation:

- Someone else will manage my risk.
- The risk is not relevant to my organization.
- Won’t taking action just slow me down?
- No one is telling me that I must act.
- What reward do I get from mitigating risk?
- It is too costly to mitigate?
- Why worry about it? It could never happen to me.
- It is too large to manage, and success is not guaranteed.

In reality, these approaches are not mutually exclusive. Mitigation strategies tend to involve parts of both – like global risks themselves they are dynamic and complex.

In the 2006 report, the Global Risk Network developed the idea of the “5 pathways” to mitigation, defining five elements of risk mitigation strategies: improving insight, enhancing information flow, refocusing incentives, improving investment and implementing through institutions. In the 2007 report, these “5 pathways” have been applied to the “core global risks” to achieve an understanding of where mitigation efforts should focus.

The "5 Pathways" to Mitigation

- **Improving insight**: moving risks from the unknown to the known through research. The best mitigation strategies often derive from the changed mindset which can result from enhanced knowledge and information.
- **Enhancing information flow**: allowing information to flow effectively between decision-makers and those experiencing the risk first-hand, to provide early warning, inform the public and exchange best practice.
- **Refocusing incentives**: creating the incentive frameworks that will allow decisions to be made to reduce risks previously considered exogenous.
- **Improving investment**: providing the investments necessary to mitigate risk.
- **Implementing through institutions**: improving (or creating) the framework needed to mitigate risks for which an institutional response is required.

Applying the "Five Pathways" to the 23 "Core" Global Risks

	Improving insight	**Enhancing information flow**	**Re-focusing incentives**	**Improving investment**	**Implementing through institutions**
Oil price shock/energy supply interruptions					
US current account deficit/fall in US$					
Chinese economic hard landing					
Fiscal crises caused by demographic shift					
Blow up in asset prices/excessive indebtedness					
Climate change					
Loss of freshwater services					
Natural catastrophe: Tropical storms					
Natural catastrophe: Earthquakes					
Natural catastrophe: Inland flooding					
International terrorism					
Proliferation of WMD					

Interstate and civil wars					
Failed and failing states					
Transnational crime and corruption					
Retrenchment from globalization					
Middle East instability					
Pandemics					
Infectious diseases in the developing world					
Chronic disease in the developed world					
Liability regimes					
Breakdown of critical information infrastructure (CII)					
Emergence of risks associated with nanotechnology					

Looking at the five pathways from left to right – gradually moving from individual and thought responses, to policy and institutional responses – a full picture emerges of the types of risk mitigation strategies which apply to different groups of risks.

For some risks, only a partial range of the five pathways may be relevant. Mitigating the emergence of risks associated with nanotechnology, for example, depends primarily upon improving insight and enhancing the flow of information. In others, the focus should be on more practical measures: refocusing incentives, improving investment and implementing through institutions.

A central element to a large number of the risks, however, is the importance of frameworks for institutional implementation. Getting the right framework – whether exclusively led by the public sector, or enabling private sector mitigation – is crucial.

The Global Risk Network proposes two possible institutional structures for risk mitigation to operate.

Two Possible Institutional Innovations for Managing Global Risks

Country Risk Officer

The Country Risk Officer concept would require governments to appoint a single Country Risk Officer, prioritizing risks on a cross-sectoral basis, exploring private sector techniques of risk assessment, management and transference.

In the corporate sector, the Chief Risk Officer (CRO) is responsible for all categories of risk, particularly risk reporting, consolidation and aggregation. Enterprise CROs take a portfolio view of risk – a Country Risk Officer would serve a similar function, acting as a focus point for strategic thinking (rather than day-to-day management) and forward action within government on how global risks can be effectively managed and mitigated.

The principal advantage of the CRO concept domestically would be to allow effective trade-offs between the priorities of different ministries, and to allow governments to escape silo-thinking. This is particularly relevant when thinking of "downstream" resilience strategies as similar measures can help mitigate the consequences of different risks: buildings which are protected against earthquakes are also likely to better withstand an explosion.

At the international level, the meeting of national CROs could provide a coordination body for global risk mitigation efforts.

"Coalition of the Willing"

An alternative institutional solution to the management of global risks is the setting up of "coalitions of the willing" regarding individual global risks involving different groups of countries in a system of flexible geometry. A common criticism of current international approaches to major risk issues is that they depend on bureaucracies that require consensus to act and that their objectives are frequently sidelined by institutional conflicts. At a time of acute global risks, the lack of decisiveness may have severe costs.

An alternative may be so-called "coalitions of the willing" whereby a number of individual, interested and vital states cooperate in a non-exclusive fashion on a specific global risk issue for a specific period of time, acting as an avant-garde for risk mitigation. Other countries will join the initiative as it progresses towards a statement of policy actions. The incentive to join is to influence a successful global policy. The incentive to pursue the risk mitigation goals seriously once inside would be a "naming and shaming" of those countries that do not meet the specific, agreed, commitments and the possible risk of expulsion.

The principal advantage of the "coalition of the willing" structure is its flexibility and the involvement of only interested states, thereby reducing the possibilities for obstruction and gradually drawing less interested states into a dialogue. The principal disadvantage of such an approach would be the inability to effectively negotiate trade-offs between different countries' approaches to different global risks. For "grand bargains" between states a coordinating role would still be required.

Focus on Mitigation: Oil Price Shock/Energy Supply Interruptions

The recent progress on mitigating the risk of an oil price shock includes reductions in oil subsidies, higher investment in energy efficiency and increased strategic oil inventories:

- Energy price subsidies have been reduced in some countries, for example, Indonesia and Russia.
- High oil prices have increased investments in the oil and gas sector, public and private investment in energy efficiency and alternative energy sources.
- Reserves have been added to Strategic Petroleum Stockpiles, in, for example, the US and China.

Future mitigation needs can be divided into those which address the question of interruptions specifically, and those that broadly address the question of demand and supply.

- Remove the silo-based approach to risk management and link energy security with considerations on climate change.
- Promote marketing of energy-efficient products and clean energy sources and attempt to promote sustainable economic growth as a positive economic choice in the developed world and as a long-term policy for emerging markets.
- Reduce legal and political uncertainties related to emissions-trading schemes and renewable energies to allow markets to fully develop their potential.
- Develop nuclear energy and coal-fired electric utility plants in a manner that is mindful of the risks and environmental concerns.
- Increase investment in refinery capacity and in Liquid Natural Gas plants, off-loading and processing terminals.
- Increase taxes progressively on fuel in the United States to European levels, made more politically palatable with an equal value cut in income tax.
- Eliminate remaining energy-price subsidies. This is particularly necessary to encourage energy efficiency in emerging markets and hydrocarbon-rich nations.
- Stockpile oil in Strategic Petroleum Reserves, but release supplies unpredictably when necessary to undercut speculative psychology in the markets.
- Promote intergovernmental cooperation on energy security policies in defined geographies – such as the European Union.
- Promote and ensure common standards for energy transit.

Focus on Mitigation: International Terrorism

Despite the increase in the overall strategic threat from international terrorism (particularly in Iraq, Afghanistan and Somalia), there have been a considerable number of tactical advances in the mitigation of terrorism risk. These range from improved security controls, to improved political understanding and better management of terrorism events when they occur, including development of terrorism insurance markets to cover some of the economic consequences of attacks and facilitate the recovery process.

On pre-event mitigation:

- In the United Kingdom, a plot to blow up aircraft between Britain and the United States was disrupted.
- The European Union is improving its security information-sharing system, through work on an EU-wide counter-terrorism database.
- The United States is improving its tracking of imports and exports, through its Automated Commercial Environment system.
- In Saudi Arabia, over 20 senior Al Qaeda operatives have been killed. A few years ago, fears that the Saudi regime was under threat were widespread – these fears are now reduced.
- The Philippine authorities are re-establishing control over Basilan and the Jolo Islands, operational centres for the Abu Sayyaf and Jemaa Islamiyah terrorism organizations.
- In Indonesia, the government's multipillar counter-terrorism campaign is being strengthened, with considerable new counter-terror legislation, the prosecution of a number of major terrorists and the support and promotion of moderate Islam as an alternative to radical theology.
- The private sector has improved physical security measures and screening.

In post-event mitigation:

- The private sector has continued progress on diversifying operations and building up resilience, for example, by establishing a second computer backbone.
- Terrorism insurance schemes have been established to spread the risk among the different stakeholders in some markets through public-private partnerships: NHT in the Netherlands, Pool Re in the UK, Gareat in France, Extremus in Germany and TRIA in the US.
- Terrorism insurance has risen: one survey of Marsh clients revealed that terrorism coverage rose from 23% in mid-2003 to 64% by the end of 2005.

Future specific needs for mitigating the terrorism risk:

- Renew terrorism insurance schemes scheduled to sunset in 2007 in some form; improve framework for public-private arrangements in other countries.
- Reach an internationally-agreed definition of terrorism and terrorist acts and build a body of transcultural values to help combat terrorism.
- Expand intelligence capabilities, while re-enforcing oversight functions to ensure that privacy is maintained.
- Improve cooperation between intelligence agencies. In regions where bilateral cooperation is already good and a level of trust has been established, transition to a more dynamic and efficient multilateral mode of cooperation.
- Improve tracking of financial flows to cut off funding to dispersed terrorist cells.
- Strengthen the monitoring of the shipment of goods to allow for the detection of explosive devices and nuclear/biological/chemical/radiological material.

Focus on Mitigation: Climate Change

As the science surrounding global climate change continues to unfold, a range of public and private mitigation measures are critical both in the immediate term and over the long term.

Some steps are already under way:

- Awareness of the impacts of climate change is rising quickly (particularly in the developed world), building public support for mitigation. Ultimately, changes in the mindset of consumers – altering their behaviour as a result – may produce considerable mitigation.
- The European Union launched an Emissions Trading Scheme in 2005.
- California has passed a law aiming to reduce greenhouse gas emissions by 25% by 2020.

But there are a number of mitigation needs which should be introduced, updated or implemented more fully:

- Raise awareness in the developing world of the impacts of climate change.
- Involve major developing countries in new frameworks for limiting future emissions' growth (particularly China and India).
- Urgently begin work on a successor to the Kyoto agreement with three central principles:
  - Involvement of the United States and major developing countries (particularly China and India);
  - Differential responsibilities for future emissions' reduction dependent upon past emissions and stage of economic development; and,
  - Common overall responsibility for climate change.
- Allow transfer of technologies which may help reduce climate change, or mitigate its impacts.
- Expand market mechanisms – such as carbon emissions' credit trading – which encourage innovation, reward efficiency and ease the development of insurance and other financial tools to manage risks inherent in emissions' reduction projects.
- Strengthen current market mechanisms by ensuring a stable and predictable legal environment and ensuring ambitious overall limits on emissions.
- Create strong incentive structures and provide research funds to foster possible "breakthrough technologies" such as hydrogen fuel cells or advanced thin film photovoltaics, particularly in the power-generation sector.
- Provide investment or tax incentives that level the playing field for capital intensive investments in clean-coal combustion and carbon sequestration.
- Improve cost-effective reductions in emissions at the business and domestic level. Many well-managed corporations have already identified more efficient processes that can lead to cost savings in their production processes, transportation and facilities management. These should be extended.
- Improve the protection of private and public operations from discontinuities caused by severe physical risks due to climate change, including strategic assessments of long-term vulnerabilities.
- Encourage long-term adaptation in countries where impacts of climate change are most likely to be felt, by increasing adaptation aid and creating financial structures to leverage global insurance capacities.

Focus on Mitigation: Pandemics

The nature of the pandemic threat has become much more widely understood over the last year:

- A pandemic is not a one-time occurrence, but occurs as a series of waves.
- An outbreak cannot be predicted – multiple, simultaneous geographic outbreaks may occur with concurrent failures in the supply/value chain.
- The behavioural response to an outbreak – the "infodemic" element – may be more significant than the virus itself.

As a result, mitigation measures have advanced, both for the specific HN51 virus, as well as preparedness for a pandemic outbreak more generally:

- There has been an increase in exchange of best practices between businesses.
- The coordination of international organizations has improved.
- The awareness of the significance of national transparency in order to aid any future international effort makes the control of the disease more likely.

Some future mitigation needs may only become available once an outbreak has occurred and its origins and vector of transmission have been identified. But many mitigation options remain incomplete or not fully exploited:

- Strengthen collaborative preparedness activities, including simulations and decision-modelling exercises among national, local and value-chain interdependent parties.
- Manage expectations of what government will and will not do if an outbreak occurs, endorsing wider accountability in the event of a pandemic and driving financial responsibility.
- Improve governmental ability to provide timely, clear and effective information, and improve education of first-responders.
- Increase research into the identification of critical choke-points in the supply/value chain where skill sets are rare, interdependencies are greatest and the risk of triggering systemic failure is highest.
- Invest in surge capacity in healthcare services.
- Encourage private sector investment in surge capacity for vaccine manufacture.
- Develop effective domestic plans for the distribution and administration of vaccines and other medication in a pandemic situation.
- Reach understanding between manufacturing and consuming countries on an equitable and agreed basis for international distribution of vaccines in a pandemic situation.
- Encourage the maintenance of basic supplies at home.
- Explore the possibility of "work-from-home" for some businesses, reducing the potential for infection and spread.
- Undertake an administration-wide skill-set evaluation to allow planning for replacing skilled personnel, should they become unavailable.
- Explore the feasibility of alternate financing schemes to serve as a backstop and transfer the risk to a larger community, including the public sector, to avoid systemic failure.

All of the four global risks focused on here – oil-price shocks, international terrorism, climate change and pandemics – would benefit in different ways from the institutional innovations suggested in this report: a Country Risk Officer or the setting up of "coalitions of the willing" around particular global risks.

A Country Risk Officer would allow prioritization to be made effectively and resources to be focused on different risks at different times – creating, for example, the kind of surge capacity for dealing with pandemics which is outlined above. A Country Risk Officer would be equally well placed to understand the interconnections between many global risks – understanding how some mitigation measures for climate change might help improve energy security while others would transfer the risk, or understanding how improvements in preparedness for natural catastrophes could also strengthen resilience to international terrorism. Faced with a portfolio of mitigation options, a Country Risk Officer would be able to shape the necessary strategic understanding and response to global risks that are needed.

The "coalition of the willing" idea would allow for flexibility and clarity in adopting many of the specific mitigation options suggested above. The appropriate governance, management and mitigation of global risks are only likely to emerge from the expanding participation of interested parties. Some of the specific mitigation ideas above are already under way in some parts of the world, but their impact is reduced by the partial nature of their adoption elsewhere. Structured "coalitions of the willing" would allow momentum to build up around mitigation measures, bringing countries and businesses into an evolving set of standards, rather than seek to achieve an overarching arrangement at the outset. As such, a "coalition of the willing" would reflect the realities of global politics – and attempt to derive dynamic advantage from them.

In some cases, this approach would not work: a global definition of terrorism and terrorist acts is clearly a task which requires cross-cultural consensus from the outset. However, for others – such as an oil-price spike – this structure might create exactly the balance between inclusiveness and manageability that is required to produce agreement on appropriate measures for global risk mitigation.

There is no guarantee of mitigation initiatives preventing global risks from causing major disruption to the international system, economic damage and irreparable human loss. Global risks cannot – for the most part – be mitigated out of existence. But inaction in the face of global risks is not an option – either for businesses or government.

Annex

"Core" Global Risks

Economic risks	
Oil price shock/energy supply interruption	Oil prices rise steeply due to major supply disruption.
US current account deficit/Fall in US$	Unsustainability of US current account deficit triggers a major fall in the dollar, with impacts throughout the financial system.
Chinese economic hard	China's economy slows to 4% growth – potentially as a

landing	result of protectionism, internal political or economic difficulties.
Fiscal crises caused by demographic shift	Aging populations in developed economies force governments to raise taxes or borrowing, resulting in economic stagnation. (A similar fiscal crisis might emerge outside the 10-year timeframe in China).
Blow up in asset prices/ excessive indebtedness	House prices (and other prices) collapse in the US, UK, and several continental European countries, pushing consumers into negative equity and causing a recession.
Environmental risks	
Climate change	Climate change generates extreme events (e.g. wind-storms and heat-waves) and gradual changes with severe impacts on infrastructure (e.g. exposure of pipelines in permafrost, cities at sea level etc.), agricultural yields and human lives.
Loss of freshwater services	Extensive deterioration of freshwater services, aggravated by water scarcity and quality degradation, leads to water shortages (impact on agriculture, businesses and human lives) and a further increase of infectious diseases.
Natural Catastrophe: Tropical Storms	An extremely strong hurricane of category 5 passes directly over Miami, Florida, or a super typhoon hits Nagoya and/or Tokyo bay; economic losses are catastrophic. In the past, storm surges associated with tropical cyclones have caused high human death tolls.
Natural Catastrophe: Earthquakes	A strong earthquake hits the greater Tokyo area or a similar earthquake hits the greater San Francisco area.
Natural Catastrophe: Inland Flooding	Extreme inland flooding (on the Mississippi, Yangtse or Rhine) causes significant economic losses, fatalities and disruption, particularly downstream.
Geopolitical risks	
International Terrorism	International terrorists mount attacks with conventional and chemical weapons (but not nuclear weapons), disrupting economic activity and causing major human and economic losses. Indirectly, attacks aid retrenchment from globalisation and reduce collective will to deal with other global risks.
Proliferation of Weapons of Mass Destruction (WMD)	Proliferation of WMD accelerates, fatally weakening the nuclear Non-Proliferation Treaty and leading to spread of nuclear technologies and aspiration to weaponisation.
Interstate and civil wars	Major interstate war – or equally significant civil war – breaks out. Possible scenarios include: conflict between China and the US over Taiwan, Iran/US conflict, conflict on the Korean peninsula, or flare-up of tensions in the South Caucasus.
Failed and failing states	The pattern of failed and failing states continues to grow with a widening gap between geographies of order and

	disorder. This will involve states such as Pakistan, Afghanistan, Iraq, and countries in Central Asia, Africa and Latin America.
Trans-national crime and corruption	Corruption continues to be endemic and organised crime successfully penetrates the global economy. State authority is weakened, growth slows and opportunities in what are now called “emerging markets” are foreclosed as a result.
Middle East instability	The Israel-Palestine conflict and Iraqi civil war continue. The Islamist challenge and success issues raise domestic and international tensions; the US fails in its objectives.
Retrenchment from globalisation	Rising concerns about cheap imports and immigration sharpen protectionism in developed countries. Emerging economies become more nationalist and state-oriented. The result is first stagnation, then decline, of global trade, while global political will to deal with other global risks is reduced.
Societal risks	
Pandemics	A pandemic emerges with high mortality (between 0.1 and 4 per thousand) among economically productive segments of the population. Vaccine development can only start once the virus emerges; distribution is typically too slow to have any impact on the first wave of the pandemic.
Infectious disease in the developing world	Incidence of HIV/AIDS continues as arguably the most acute threat to global human welfare, with 4-5 million deaths in 2005. Incidence continues to rise, with serious risk that increasing infection rates in the former Soviet Republics and South/Southeast Asia will take a turn for the worse.
Chronic disease the developed world	Obesity, diabetes and cardiovascular diseases become widespread; healthcare costs increase; resistant bacterial infections rise, sparking class-action suits and avoidance of hospitals.
Liability Regimes	US liability costs rise by four times GDP growth. This acceleration spreads to Europe and Asia, with insurers increasingly viewed as a source of funds for dealing with social problems. Capacity for global insurance is thereby reduced, constraining investment, innovation and growth.
Technological risks	
Breakdown of Critical Information Infrastructure (CII)	A major disruption of the availability, reliability and resilience of CII caused by either cyber crime, terrorist attack or technical failure, causing a domino effect on IT-dependent applications. Results are felt in major infrastructure: power distribution, water supply, transportation, telecommunication, emergency services and banking and finance, amongst others.

Emergence of risks associated with nanotechnology	Studies indicate health impairment due to under-regulated exposure to a class of commonly-used nano-particles (used in paint, nano-coated clothing, cosmetics or healthcare) exhibiting unexpected, novel properties and easily entering the human body. Primary impacts on human health; secondary impacts on public confidence in technology and other products.

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