

Global Risks 2008

A Global Risk Network Report



A World Economic Forum Report

in collaboration with

Citigroup

Marsh & McLennan Companies (MMC)

Swiss Re

Wharton School Risk Center

Zurich Financial Services

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REF: 090108

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Introduction

Over the last year, a series of risk issues – from the liquidity crisis in the financial markets to the emerging concerns over the long-term security of food supply – have focused global attention on the fragility of the global system. An awareness of risk and risk management is increasingly viewed as a prerequisite for effective control in both the private and public sectors.

This year will be no different. Uncertainty about the short- and medium-term future is as high as it has been for a decade. Economically, the uncertainty centres on how the global economy will respond to the spreading liquidity crunch of 2007. The mispricing of financial risk, a central theme of *Global Risks 2007*, may have further to unwind. Geopolitically, uncertainty is focused on the

possibility of an escalation in tensions with Iran and concerns over the long-term integrity of the states of Iraq and Afghanistan.

The result of uncertainty could be inaction in dealing with other, less immediate, global risks. Action to mitigate climate change, for example, may be put in danger should the global economy weaken substantially – even though many of the political, economic and investment decisions which will shape the future path of global climate will need to be made in the next five years. Proactive management of globalization to ensure its long-term sustainability may be derailed by the prevailing currents of uncertainty. But inaction on long-term risks will only weaken the global capacity to manage future challenges.



Under conditions of global stress, one core question of global risk management will become more salient than ever: who owns the risk? Without a shared understanding of ownership, achieving the trade-offs which may be necessary to mitigate global risk equitably and sustainably will be extremely difficult. Without clarity on who is responsible for managing global risk, turning aspirations into actions will be impossible. Without frameworks which connect ownership of risk with the responsibility to mitigate it, and which share the upside and downside of risk among stakeholders efficiently, the market mechanisms for managing risk will fail to improve our aggregate global resilience in the face of inevitable risk events. And without leadership from the business and political communities on all of these issues, we may find our global future shaped more by risk events than by our power to anticipate, manage and mitigate them.

The present report looks at global risks from a range of different perspectives.

The first part of the report focuses on four emerging issues that are shaping the global risk landscape: systemic financial risk, food security, supply chains and the role of energy. On systemic financial risk, we put current market turmoil in the historical context and ask how the transformation of the global financial system over the last two decades may require us to rethink our expectations and understanding of systemic risk in the future. On food security, we discuss how the subject has moved from the periphery of the global risk landscape to its centre, and ask whether the world is ready to cope with the various trade-offs that the new food economy is generating. On supply chains, we investigate a potentially hidden set of vulnerabilities in the global economy to supply chain disruptions. Finally, on energy, we outline the emergence of a range of energy-related risks and ask if the world can move towards secure and sustainable energy.

The second part of the report presents our collective assessment of global risks in 2008, based on a revised taxonomy of risk, and building on the assessments of past years. In the third part, we look at the methodological hurdles around the representation of interconnectedness and demonstrate how risk "squeezing" and homogenization of risk are changing the way we perceive risk globally. In the fourth part of the report, we examine the role of financial markets as tools of risk transfer and risk mitigation for an increasingly broad range of global risks. Finally, in the fifth part, we take forward our discussions on the construction of risk mitigation coalitions and country risk management, establishing a set of principles for country risk management which the Global Risk Network will develop in 2008-2009.

The Global Risk Network, part of the World Economic Forum since 2005, will continue to generate discussion and dialogue between the corporate and public sectors. In 2008-2009, the World Economic Forum and partners of the Global Risk Report – Citigroup, Marsh & McLennan Companies, Swiss Re, the Wharton School Risk Center and Zurich Financial Services – will broaden the participation of the global business and policy community.

1. Focus on Emerging Issues in Global Risk

In *Global Risks 2008*, the Global Risk Network has focused on four emerging issues which may fundamentally shape not only the year ahead, but the decades to come. These issues – systemic financial risk, food security, supply chains and the role of energy – are all central to the functioning of the world economy and to the well-being of global society. The risks associated with them cannot be eliminated. But they can be better understood and better managed.

Systemic financial risk is the most immediate and, from the point of view of economic cost, the most severe. The financial conditions of the past decade have allowed for an exceptional period of economic growth and stability. But, with so many potential consequences of the 2007 liquidity crunch unresolved, the outlook for the future is more uncertain at the beginning of 2008 than it was a year ago.

A recession in the United States cannot be excluded in the year ahead, and economists are divided on whether domestic-led growth in Asian markets can drive the global economy. In Europe, the impact of economic uncertainty may be highly divergent. The role of the financial sector in the United Kingdom leaves it particularly vulnerable to financial turmoil, while large current account deficits in some central and eastern European economies may prove increasingly unsustainable in 2008. The resilience of the export-led growth of other major European economies may also be brought into question if disruption in the financial markets spreads more widely. Over the much longer term, the dollar may find itself under increasing pressure as the global reserve currency, undermining the geopolitical position of the US and foreshadowing the end of a hegemonic period in global economic history.

Food security, at the nexus of a number of issues from energy security to climate change and water scarcity, may be emerging as one of the major risks of the 21st century. Long- and short-term drivers – population growth, changing lifestyles, climate change and the growing use of food crops for biofuels – may be shifting the world into a period of more volatile and sustained high prices. The consequences, particularly for the most vulnerable communities, may be harsh.

Extended supply chains, which have allowed global economic integration to flourish in the last two decades, may be concealing increased vulnerability of the global system to disruptive risks. Geographic concentrations of risk in economically efficient zones of production may have improved global welfare, but are businesses and governments prepared for the consequences of a risk event in these concentrated areas?

Finally, this section looks at some of the problems associated with managing the long-term future of energy, particularly perceived risks to energy security and risks from global climate change.

What emerges from discussions is a common problem: the growing misalignment of risk bearers under conditions of globalization. In financial markets, the atomization of risk has generally allowed far greater participation in the risk economy and vastly improved financial diversification, but it may also have resulted in a systemic under-appreciation of risk. For the food economy, shifts towards policies perceived to improve domestic energy security – such as an increased use of biofuels – and risks associated with water and climate change may be shifting power and resources to crop producers and some developed economies at the expense of global equity. In global supply chains, dangerous accumulations of risk may not be recognized and, yet, may threaten a systemic crisis should one part of the supply chain fail. Finally, the mismatch between incentives for fundamental changes in the global energy economy – between developed and developing countries and between different elements of the private and public sectors – is complicating the emergence of global solutions.

This underscores the necessity to improve understanding of how risks interconnect, how we can build coalitions to manage risk, and how the different trade-offs between risk mitigation solutions can be appropriately identified. Our main conclusion is the need for the governance of globalization to enhance efficiency, ensure equity and manage a global risk environment which is both more complex and more challenging than ever before.

A. Systemic financial risk: do we understand it, can we mitigate it?

What is systemic financial risk?

In general terms, the manifestation of systemic financial risk involves a system-wide financial crisis, typically accompanied by a sharp decline in asset values and economic activity. In all cases, systemic financial risk involves the spread of instability throughout the financial system as a whole with results that are sufficient to affect the real economy.

Manifestations of systemic financial crisis are relatively rare. In the past 20 years, systemic financial risk events have included the equity crash of October 1987 ("Black Monday"), the Japanese asset price collapse of the 1990s, the Asian financial crisis of 1997 and the Russian default of 1998 (which led to the demise of the Long-Term Capital Management (LTCM) hedge fund).

Each of these episodes was characterized by an abrupt loss of liquidity, discontinuous market moves, extreme volatility, sharp increases in correlations and contagion across markets, and systemic instability. While the pathways of contagion of systemic financial risk are often well understood in retrospect, and the conditions for a systemic financial risk event may be well identified ahead of crisis, the precise triggering event is rarely predicted. Systemic risk is an inherent element of the global financial system.

The increasing complexity of financial markets, and the rate at which financial markets are evolving, make the task of avoiding and managing systemic financial risk extremely difficult. Increasing global interconnectedness has multiplied the possible pathways for the contagion of financial risk. Layers of leverage may have increased the possibility for magnification of risk. Financial innovation, in the form of complex financial instruments, may ultimately contribute to the opacity of systemic risk. At the same time, however, the increasing importance of the financial sector in the real economy has made the question of systemic financial risk more important than ever.

This section of the report discusses the key drivers, characteristics and impacts of systemic financial risk, which private financial institutions, governments, regulatory authorities and central banks will need to integrate into their approaches to markets if they are to identify and survive the next systemic financial crisis.



Mispricing risk: the underlying seeds of crisis

At the beginning of 2007, the economic mood was generally positive. The consensus pointed to a year of continued strong global economic growth. Risk premiums were at historically low levels. In hindsight, the widespread complacency with respect to the true nature of risk served only to confirm the weakness of financial markets in predicting systemic crisis.

But there were identifiable "weak signals" which suggested the potential for financial crisis. An asset price collapse was the top risk identified in *Global Risks 2007*. Warnings voiced by the Bank of International Settlements were ignored, while a Global Risk Network briefing issued in January 2007 warned that a global re-appreciation of risk could be expected, with three major challenges to the global economy: a housing recession, the beginning of a liquidity crunch and high oil prices.

All three were realized over the course of 2007. First, the US housing recession, which began in late 2006, has accelerated, with new housing construction at its lowest level since the early 1990s and house prices down nationally. Second, the world has experienced a crunch in global liquidity, affecting

even essentially solvent financial institutions, and raising the prospect of tightening credit as banks are forced to readjust their capital ratios. Finally, the dollar price of oil rose to an all-time high, close to the inflation-adjusted peak of the early 1980s.

But if an eventual global re-appreciation of risk was foreseeable in early 2007, the timing and precise nature of the trigger event was not.

In early 2007 many expected that any systemic crisis would be the consequence of an unwinding of global economic imbalances – notably the US current account deficit. The actual trigger for the current systemic crisis was the collapse of a critical segment of the US mortgage business – the sub-prime mortgage market. It was widely thought in early 2007 that the main threats to financial stability would come from leveraged hedge funds. But it turned out to be problems related to complex security structures and off-balance-sheet vehicles created by the banking sector that have generated the systemic elements to the current crisis.

Predicting *what* will happen is easier than predicting *when* and *how* events will unfold.

Liquidity crunch: history repeats itself?

The meltdown of the US sub-prime mortgage market and the growing prospect of a global credit crunch dominated financial markets in the second half of 2007. An abrupt evaporation of liquidity and dramatic repricing of risk led to widespread financial instability, ultimately threatening the viability of smaller financial institutions even in well-regulated markets such as Germany and the United Kingdom. The US Federal Reserve has projected direct losses related to sub-prime of US\$ 150 billion; non-sub-prime financial losses may be considerably greater.

As in past systemic financial crises, complacency in credit standards – driven by perverse incentives and moral hazard – lowered risk premiums to unsustainable levels. The periodic underpricing of risk in financial markets may be structural and to some extent unavoidable. But few systemic financial crises are entirely dissimilar to earlier episodes. This suggests room for improvement in the management of crisis including better early warning systems and more coordinated and forceful action by market

supervisors and central banks. Financial crises may never be avoided. But their frequency and severity may be significantly reduced.

Is the financial system now more stable and resilient? Some recent experiences – such as the relatively benign Y2K rollover, the very short-lived market disruption following the events of 9/11, and the relatively muted effects of more recent spikes in the dollar price of oil – have led experts to conclude that markets are now more resilient to exogenous shocks. But many would argue that the overall resilience of the global financial system will only become fully evident under conditions of severe stress over the next year.

A system transformed

Over the last 20 years, financial markets have undergone a revolution, driven by deregulation, a rapid pace of financial innovation, global financial integration and the increasing role of the financial sector in the economy.

The salient features of the transformation can be summarized in six points.

- **Deregulation:** The process of deregulation has deeply affected the financial markets of advanced economies by removing barriers to entry; reducing artificial borders between types of financial institutions; increasing cross-border competition; encouraging the emergence of large, complex financial institutions; and spurring financial innovation.
- **Financial innovation:** There has been an explosion in derivative and structured products. Such innovations have allowed for more efficient allocation of financial resources. Many argue that this has helped strengthen the global financial system by better apportioning risk. However, innovation raises challenges in terms of evaluating risk, correctly identifying ultimate bearers of risk and assessing whether they can manage it. Rating asset classes without market history has put rating agencies in a crucial position in global markets. Regulators may not have the capacity to monitor the range of risks within the financial system. And even as Basel II comes into force, regulation may not be evolving as fast as market innovation.

- **Rise of alternative capital pools:** The rise of hedge funds, private equity and sovereign wealth funds has changed the balance of the global financial system. Hedge funds are sometimes highly leveraged (with consequently higher risk profiles) with shorter investment time horizons than standard investors, operating under conditions of reduced disclosure and oversight. Private equity firms, while often investing for the longer term, are similarly unburdened by regulatory oversight, and sometimes highly leveraged. Sovereign wealth funds, which have become particularly important as rising oil prices and global economic imbalances have massively increased the foreign reserves of certain countries, present a new set of challenges, including relative lack of transparency over investment strategies, concern over possible political intervention and potential large-scale market moves.
- **Financial services convergence:** The borders between different types of financial institutions are becoming blurred, increasing risk transfer between them. Banks are supplying capital for insurance risks, while both banks and reinsurers are using insurance-linked securities (see page 32) to transfer insurance risks to the capital markets.
- **Role of non-bank institutions and intermediaries:** The increased role of market intermediaries may have widened the offering of structured financial products to investors. But not all intermediaries are subject to consolidated risk-based capital frameworks or the full complement of supervisory constraints. The originate-to-distribute (OTD) model may have lowered underwriting standards while the growing importance of credit rating agencies – which play a key role in pricing risk but which do not hold it themselves – may raise similar challenges with respect to incentives.
- **Shift to multipolar currency regime:** While the US dollar remains the global reserve currency and is likely to remain so for years to come, over time the creation of the euro and the growing importance of emerging country currencies will lead to a weakening of the dollar's dominance, with consequences for the global management of central banks' reserve holdings and the resolution of currency alignments.

What are the implications of these changes for the nature of systemic financial risk?

When considering the implications of these changes for systemic financial risk, three major observations stand out:

- **Risk ownership has been decentralized:** The growth of securitization and risk transfer has led to risks being disaggregated and spread to diverse owners. This demands a shift in emphasis from the widely studied and understood "bank run" model of systemic risk to a new "market-based" model, where financial crises manifest themselves in markets rather than institutions; though of course institutions must still be monitored.
- **Risk transmission has become more important:** Increasing interconnectedness has multiplied the points of potential failure and increased the significance of systemic linkages. Behavioural dynamics are critical. One example of the importance of risk transmission is the carry trade where there is potential for large, abrupt reversals of cross-border capital flows which could trigger systemic crisis.
- **Risk management is critical:** Complexity has increased the need for effective risk management. At the enterprise level, there is rising adoption of enterprise risk management. At the national and international level, increasing attention is paid to financial and political coordination.

On balance, these developments appear to have increased the financial system's capacity to assume and distribute risk, and they also appear to have made it more stable. More risk is apportioned to market participants who have indicated a willingness to absorb risk. But, as recent developments highlight, this appears only to be true under "normal" market conditions. The complexity and near infinite feedback loops of the modern financial system have exposed it to a small risk of very large systemic shocks. Some analysts postulate that the financial system may indeed be more pro-cyclical if the growing dispersion of risk is not coupled with a better understanding of the driving factors of risk segmentation and diversification.

Anatomy of a Systemic Financial Crisis



Note: Whatever the proximate cause of a systemic financial crisis, the anatomy of apprehension, fear and contagion is common to most.
Source: World Economic Forum

Hence, we may be facing a paradox: while the financial system has been made more efficient and stable in normal times, it is now also more prone to excessive instability in really bad times. At the same time, the increased importance of the financial sector in the global economy means that the impact of financial instability on the real economy has also increased.

Pathways to catastrophic failure

All the trends above can be observed in the recent turmoil in financial markets.

The ensuing liquidity freeze and broad-based asset write-downs indicate that many existing risk models were inadequate, failing to reflect the dynamic

Open questions on systemic financial risk

- What types of systemic propagation mechanisms might result in a small shock becoming a major financial crisis?
- How can negative or self-reinforcing feedback loops (such as bank runs) be interrupted or short-circuited?
- What is the role of central banks in an environment where lending activities are performed by many unregulated market participants?
- To what extent does the mandate to forestall and defuse financial crises introduce moral hazard and underinvestment in management of market and liquidity risks?
- What potential avenues for cross-pollination exist to identify useful concepts and mitigation models from other domains?
- What role will the emerging giants of China and India play in the international financial system?
- Will market-driven, regulatory and supervisory approaches be sufficient, or is more regulatory oversight required? And how could private sector initiatives supplement these?
- What is the role of credit rating agencies in financial stability, if any?

complexity and unpredictable nature of financial crises. Statements to the effect that 10-standard deviation events were occurring several days in a row demonstrate how much is still to be learned about the underlying distributions, and so-called "tail" events, which refer to the extremes of a probability distribution.

New thinking may be urgently required.

Conventional wisdom emphasizes, in equal measure, the two components of risk: likelihood and severity. This naturally drives risk ratings, prioritization and corrective actions focused both on prevention (i.e. reducing likelihood of the event) and mitigation (i.e. reducing severity of the event).

But changes in the financial markets, while providing many benefits, have also created new and unforeseen risks which may be more susceptible to exogenous shocks (such as geopolitical risk) or internal factors (such as speculative bubbles). Many of these risks are unpredictable, making prevention and mitigation impossible.

It may not make sense to attempt to eliminate risks which ultimately represent a source of opportunity as well as hazard. Rendering the global financial system as flexible and resilient as possible by improving early indicators, enforcing more stress testing, enhancing understanding of tail risk and requiring better contingency planning may be more effective.

Ultimately, strategies to deal with systemic financial risk must reflect the fundamental shift in the global financial system to a market-driven model. There is considerable scope for increased public and private sector collaboration on stress testing, liquidity management, risk assessment and prevention. One example is the formation of the Counterparty Risk Management Policy Group in the wake of the collapse of Long-term Capital Management, which has helped to reduce risks stemming from hedge fund leverage.

B. Food security: the emerging risk of the 21st century?

In 2007, prices for many staple foods reached record levels. The price of corn in late 2007 was 50% higher than 12 months previously. The price of wheat was double. Global food reserves are at their lowest in 25 years and, as a result, world food supply is vulnerable to an international crisis or natural disaster.

Food security has emerged as a major risk, marked by both local and global consequences, trade-offs between different mitigation priorities and a disproportionate impact on poorer communities. Embedded in a web of other global risks, there is considerable uncertainty as to whether food insecurity in 2007 is the result of short-term conditions which have existed in various times throughout history, or whether a more fundamental change is taking place, with a range of underlying trends bringing food from the sidelines to the centre of the global risk discussion in years to come.

What is food security?

According to the Food and Agriculture Organization (FAO), food security is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their

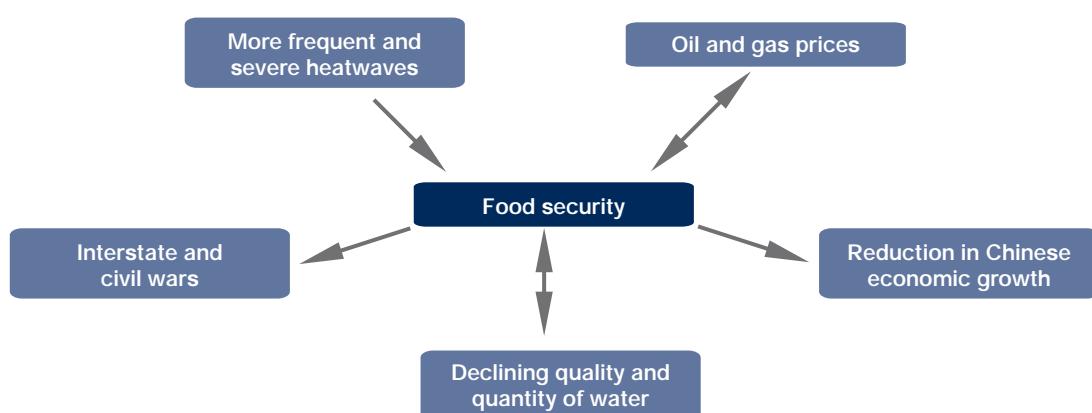


dietary needs and food preferences for an active and healthy life. Food security, similar to energy security, is not only about avoiding physical disruptions to supply, but also about ensuring supply at a price which allows economic activity and well-being to flourish.

Impacts are global and varied

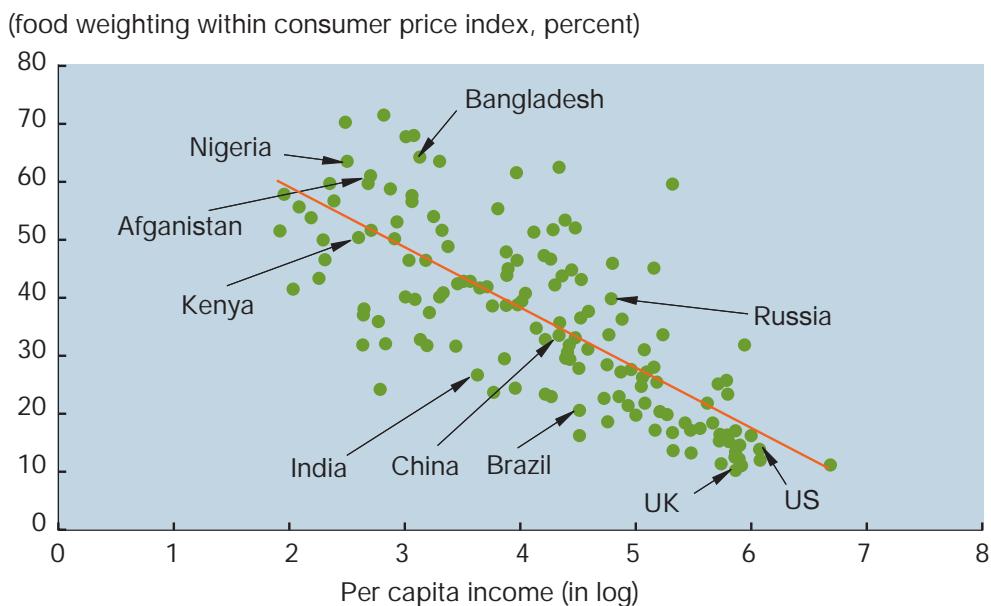
In the past, food security generally concerned the least developed countries, particularly those in conflict and those facing uncertain weather patterns. But, more recently, concerns about sustainable food security have spread to developed countries which have not generally considered themselves exposed to food insecurity. For example, the United Kingdom has historically relied on the depth of international markets to ensure food supplies at a reasonable

Food Security: At the Nexus of a Range of Global Risks



Source: World Economic Forum

Rising Food Prices, Unequal Impacts



Note: Poor people tend to spend relatively more of their income on food, and therefore suffer more when food prices go up.
 Source: International Monetary Fund

price, but this model may be put under stress in the future. In 2007, food and drink prices rose at their fastest rate in 14 years, at 4.7%. In the US, food prices were up 4.4% year-over-year at the end of 2007 – double the rate of non-food, non-energy inflation – partially due to increased acreage devoted to corn to make ethanol.

China and India are also exposed to pressures on global food security, and their domestic experiences may have global economic consequences. In China, average incomes have barely risen while food prices have soared: by 17.6% overall, 70% for pork products, 30% for vegetables and 34% for cooking oil. Combined with the sharply rising dollar price of oil, high food prices in China could increase global inflation.

Beyond the potential economic consequences of rising food prices is the well-established relationship between food prices and political stability. In 2007, surging prices of basic foods caused domestic unrest in a number of different countries. In March, thousands of Mexicans demonstrated against the four-fold increase in the price of flat corn. In

September, Italians organized a one-day strike against rising pasta prices. In October, in West Bengal (India), food riots erupted as a result of disputes over food rationing.

In some countries, particularly where the success of government has been historically linked to administrative control of basic supplies, governments have intervened to limit the political consequences of rising food prices. The Russian government acted to control prices of staple foods ahead of the December 2007 parliamentary elections. In Egypt, which experienced political upheaval in the wake of price increases of bread in 1977, subsidies to bread producers have been increased to mitigate the impact of rising global wheat prices. In China, soybean import duties have been reduced, subsidies to farmers have been boosted to encourage agricultural production – particularly of pork and milk – and plans are to provide support for low-income urban residents against food price increases.

The drivers: population, biofuels and climate change

Global population and changes in lifestyle

The United Nations has predicted the global population will rise above 9 billion by 2050, placing additional pressure on the global food supply. But these pressures are sharply accentuated by an increasing demand in developing countries for protein-rich foods which require more grain (and water) to produce, and by the increasing constraint of available agricultural land. Annual per capita consumption of meat in China has increased from 10 kilograms in 1950 to 40 today. Over the same time period, the availability of arable farmland per head of global population has declined from one acre to half that. Many experts believe that for these reasons increases in the price of food are likely to be sustained.

Food or fuel: how biofuel production may impact food security

The use of crops to manufacture biofuels is increasing globally – often with support of governments aiming to reduce carbon emissions or to reduce dependence on imported sources of energy. Biofuels are on course to consume up to 30% of the US corn crop by 2010.

Over the long term, the growing importance of biofuels has prompted fears that the dynamics of the energy economy will be introduced into global food markets, dramatically increasing price volatility, particularly of staple foods. But, even over the short term, the use of crops for biofuels raises a number of complex trade-offs common to the management of many global risks.

The first of these concerns global equity: any shift from food production to biofuel production has different consequences for different communities. Crop exporters may benefit, as may communities where food expenditure is a minor part of overall expenditure. But others may suffer, from crop importers – including agricultural communities which import grain as feed for animals – to poorer communities where food purchased on the open market is a major component of overall expenditure.



The second concerns the trade-off between global efficiency and perceptions of energy security: while global efficiency would best be served by a market-determined allocation of crop resources globally to food and biofuels based on price and relative environmental efficiency, concerns over energy security may undermine the attractiveness of global collaboration. Not all techniques for manufacturing biofuels are equally efficient in terms of reducing aggregate carbon emissions. It is often a perceived national security imperative, rather than a global imperative to reduce carbon emissions, which is driving the frameworks in which biofuels are being produced.

Climate change

Climate change alone is forecast to increase the number of undernourished people globally by between 40 million and 170 million in 2100, according to forecasts by the Intergovernmental Panel on Climate Change (IPCC). Climate change may affect agricultural production by increasing the severity of weather events, by increasing the volatility of weather and by shifting rainfall patterns. Changing rainfall patterns could mean that in just over a decade, rain-dependent areas of South Asia and Africa could be producing half their current agricultural yield.

The result: uncertainty

The consequences of all these trends for perpetuating the escalation of food prices are difficult to predict. Some experts expect higher food prices to be sustained. Others believe that markets will gradually readjust to shortages as higher prices make it profitable again to grow crops for food. Policy-makers may have to return to thinking about food as a strategic asset and begin to modify food policies. Given the amount of uncertainty, the resilience of the world's food system will be severely tested in the next few years.

C. Hyper-optimization and supply chain vulnerability: an invisible global risk?

Economic globalization has transformed the operational structures of both business and government. Outsourcing – particularly of manufacturing but increasingly of standard business services – has been a major driver of global prosperity by allocating scarce global resources to businesses and geographies with a comparative advantage to produce particular goods and services most efficiently. Improvements in technology and global logistics, and reductions in trade barriers have all facilitated the integration of previously separate regional economies. As a result, international and intra-regional trade has expanded at a faster rate than the global economy over the last 20 years.

But, as the global economy has become more integrated, vulnerability to disruption of the supply chains which hold the global economy together may have increased. Resilience is no longer just about internal management.

A global issue

All companies and governments dependent on external suppliers are exposed to the risks of disruption in their supply chain. But the extent and complexity of current global supply chains mean that the problem of supply chain management is not limited to a single enterprise or industry: even a relatively small supply chain disruption caused by a global risk event may ultimately have consequences across the global economic system.

The economic optimization of supply chains, with the geographic concentration of risk as a frequent corollary, has enhanced the systemic vulnerability to a supply chain failure. In September 1999, global semiconductor prices nearly doubled following an earthquake in Taiwan, China, a key centre for supply. Supply chains frequently appear to disperse risk between multiple parties, but they can also, as in this case, lead to an unrecognized aggregation of risk.

Effective preparation and management of supply chains may prevent the contagion of global risks and limit the consequences of a localized risk event. But

mismanagement of supply chains may result in them serving as a transmission mechanism of global risk, amplifying the disruptive impacts of a local risk event at the systemic level and producing consequences far beyond the corporate sector. A crisis in the supply chain of a private sector manufacturer of vaccines, for example, could rapidly develop into a public health crisis, particularly in the context of the ongoing global risk of pandemics and infectious diseases. Building a culture of supply chain risk management across public and private sectors may be a first step to broader global risk mitigation.

However, despite their importance both at the level of individual enterprises and at the level of the global economic system, vulnerabilities to the supply chain are generally poorly understood and managed. This is partly because the risks in the supply chain are obscured, as enterprises and governments may be indirectly exposed to a global risk disruption through a complex range of sub-supplier arrangements. But in some measure this is due to the range of possible global risk disruptions – from geopolitical risk to a natural catastrophe to pandemics. A US- or European-based company which sources key components from Asia will indirectly face risks that they may never encounter domestically, as well as very different cultural approaches to the management of risk. Conversely, a recent survey conducted by Marsh Inc. on 62 companies based in Asia found that only 21% had full business continuity plans to protect against business interruption arising from events such as natural disasters or terrorist attacks.

Given the complexity and interdependency of global risks, developing a realistic and effective risk management and mitigation strategy can be daunting. However, there are measures that can be taken to better understand the volatility of supply chains and to reduce the impact of global risk transmission through supply chains at the enterprise and national level.

At the enterprise level, the first step is to understand the value added in each stage of the supply chain and to assess the risk to delivery of this value. A risk-return perspective – based on profit, revenue or reputational considerations – will support management prioritization and deliver the greatest return on investment. A thorough view of the supply

chain, from sourcing of raw materials to customer fulfilment, will provide a clearer view of key vulnerabilities and risk concentrations. This should be coupled with an assessment of how these affect the supply chain in terms of recovery time or extra cost implications.

A comprehensive assessment and/or quantification of the risk in the supply chain will facilitate evaluation and prioritization of proposed risk transfer, financing and mitigation strategies. For example, a certain level of loss that could arise from one of these risks may be acceptable given the firm's balance sheet and risk appetite. Hence, no risk mitigation is required. It is also possible that the risk level could be increased, e.g. by reducing the buffer inventory, thus facilitating cost savings. If the risk is unacceptable however, then a firm could opt to

increase buffer inventory, arrange alternative or back-up suppliers in different countries, or work with suppliers to improve their own business continuity and resiliency planning and thus the firm's own supply chain integrity. Whichever option is chosen, it should be influenced by understanding the risk-return of different options, and the corporate strategy and risk appetite of the business.

But, ultimately, effective management of global risks requires a collaborative and coordinated approach in public-private partnership at an international level. Given the macroeconomic and microeconomic impact of supply disruptions arising from a range of global risks, improved dialogue and policy on these risks is crucial to the effective management of the global economy. This could also be facilitated by a forum of country risk officers, suggested on page 36.

Managing Global Supply Chains: External and Internal Management



Note: Identifying critical dependencies in the supply chain, vulnerabilities to disruption and the risk threshold of the organization is the first step to managing global supply chains. But there are both internal responses and proactive external responses which need to be considered. Less traditional external management of risks may ultimately be more efficient.

Source: Marsh & McLennan Companies (MMC)

D. Energy and global risk: interconnected risks, disconnected incentives?

Energy is a key input to the global economy, but its safe, secure and sustainable provision is increasingly problematic. At the nexus of a number of different global risks – including climate change, economic and some geopolitical risks – current and future policy decisions about energy will inevitably shape the overall global risk landscape. But the incentives in place to reform the global energy economy in a way which reduces global risk holistically are not in place.

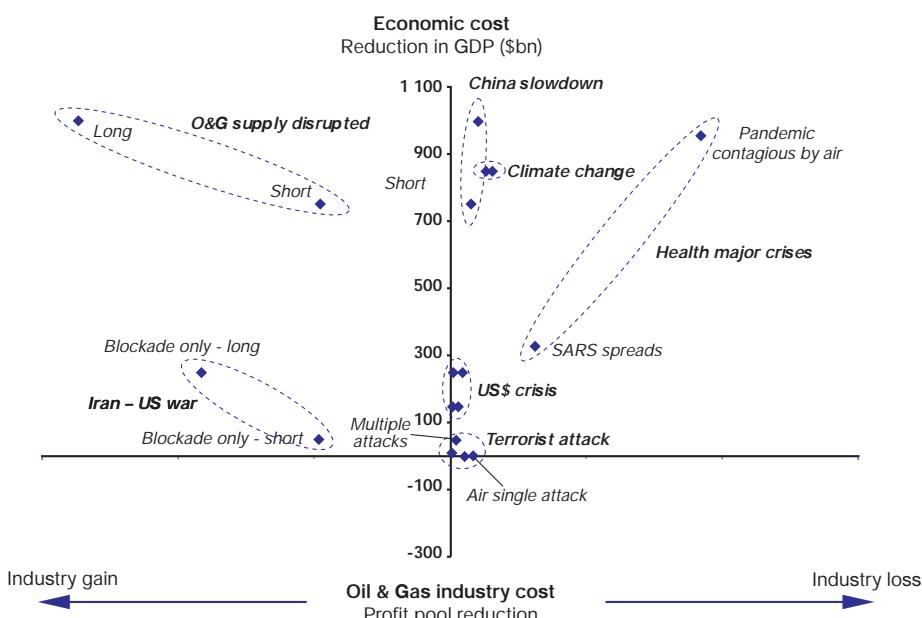
Outline of the risks

Last year saw an increase in oil prices close to the inflation-adjusted peak of the 1980s. There is considerable uncertainty in the long term over supply and demand. But over the 10-year horizon of this report there are few reasons to believe that energy prices will fall significantly – and there are several reasons to believe that energy prices may rise.

In the immediate term, the tightness of global markets has accentuated vulnerability to a supply interruption. Over the next 10 years, the International Energy Agency has identified the risk of a far sharper supply-side crunch as investment in updating energy infrastructure fails to keep pace with demand. Capital expenditure required is estimated at US\$ 11.6 trillion to 2030, but uncertainty over future returns and future regulatory frameworks around greenhouse gas emissions has meant that such investment may not be forthcoming. The International Energy Agency has predicted a 37% rise in demand for oil to 116 million barrels per day (bpd) by 2030, but investment in exploration has fallen and many experts suggest that oil production is unlikely to exceed 100 million bpd.

The global economy has demonstrated remarkable resilience to increases in energy prices since 2004. But the limits of resilience may be close to being reached. The easiest gains in energy efficiency are likely to already have been realized. Moreover, the financial conditions which have prevailed in recent years – abundant liquidity, itself a partial

Matrix of Impacts of Global Risk Events on the Oil and Gas Industry



Note: Assessments of impact are derived from a number of different global risk scenarios developed for the oil and gas industry by Marsh & McLennan Inc.

consequence of financial surpluses in energy-exporting countries resulting from high prices – have changed. Not only has the risk of higher energy prices increased but, potentially, the vulnerability of the global economy.

At the same time, the objectives of secure, reasonably priced energy and reductions in emissions of greenhouse gases (GHG) seem both out of reach and in conflict.

Coal, the only cheap, widely available fossil fuel, is linked with carbon emissions which will be unsustainable environmentally without carbon capture and storage technologies. The world's major oil reserves are located in regions of geopolitical instability. Gas, the cleanest fossil fuel, is difficult to transport and is increasingly viewed as a political bargaining chip by some major supplier states. Nuclear power, probably the best option for carbon-neutral energy from the perspective of currently available and easily scaleable technologies, continues to cause anxiety given problems of waste disposal, fear of nuclear accidents and questions on the desirability of the global spread of nuclear technologies.

Public policy has focused on green technologies such as wind power and biofuels. But these technologies come with their own problems, notably scalability. As discussed above, the use of crops for biofuels may promote greater insecurity for other crucial resources: food and water.

Globally, energy supplies are less secure even as emissions of greenhouse gases continue to rise. And the global risks continue to be strongly on the downside.

Can the world move towards secure and sustainable energy?

Such an outcome is possible, but it requires policy-makers to confront their constituencies with difficult trade-offs and requires a major shift in thinking about risk and how dialogue on risk sharing can be established. One key issue, highlighted elsewhere in the current report, is the inherent mismatch between those who bear risk and reward. Without alignment of interests and alignment of risk and reward, building complex coalitions to manage global risks will be difficult.

The disparity between the impact of global risks on different sectors of society and the economy can be seen with reference to the impact of an oil price shock. At the simplest and most immediate level, such a shock would essentially be positive for oil and gas producers, but negative for the broader global economy.

The matrix shows an analysis of the impact of a number of risk events using the oil and gas sector as an example. Results for the electricity sector show a similar pattern of disparate impact. One striking output from the graph below is the aggregate GDP cost of a disruption of oil or gas supply – reflected in the overall Global Risk rating of a steep rise in oil or gas prices as one of the most salient risks for 2008 – compared to the potential (short-term) benefits for the oil and gas industry. The mismatch between gains and losses at the industry/aggregate level, as well as the national/international level makes risk management extremely complex.

But many of the more interesting impacts are subtler: for example, the power sector in both Europe and the US is delaying investments necessary to replace an ageing fleet of power stations because of uncertainty on future regulation to reduce greenhouse gas emissions. Underinvestment today increases the likelihood of future power shortages, and consequently of future high prices for electrical power.

Meanwhile, failure to develop a clear holistic policy approach to management of both energy security and reducing carbon emissions may end up threatening both objectives. At present, the European Union appears to be drifting into high dependence on gas from a single source, high investment in renewable energy technologies that may not offer the scalability necessary to achieve ambitious targets of reductions in carbon emissions, and a highly differentiated approach to nuclear power. Should the current situation continue, it is almost inevitable that the European Union will be vulnerable to future energy shortages and will fail to achieve its stated goals for reductions in carbon emissions. The situation in the US, while different, is no better: high investment in biofuel production may bring its own risks, while dependence on foreign energy supplies continues.

The next few years will be crucial for determining a long-term global strategy on many of these issues, as a successor agreement to the Kyoto protocol is negotiated, as major investment decisions will have to be made on energy infrastructures in producer countries, as political changes may drive shifts in energy policy in the developed world, and as the emerging economies of Asia become increasingly attached to particular energy sources.

Better dialogue is needed at all levels – between emerging and developed countries and between the corporate sector and the government and regulators – so that the current misalignments of incentives can be addressed effectively. Energy security has two sides, and both producers and consumers have much to gain from predictability. Similarly, to unlock investment and innovation in cleaner energy, long-term economic viability must be assured by forward-looking regulatory frameworks and, ultimately, an economic price for carbon. Whether or not such policy changes are forthcoming at the global and national level, individual companies and the energy industry need to improve their capacity to link their own risk management and strategic decisions.

2. Assessing Global Risks in 2008

The global risk landscape at the beginning of 2008 is broadly similar to the risk landscape at the beginning of 2007. Many of the risks have remained stable in terms of the ratings ascribed to them by the Global Risk Network for likelihood and severity. A number of risks have been sharpened in definition, others have been disaggregated and one new risk – food security – has been identified. The taxonomy of

risk, separating trends of issues of concern from risks themselves, has allowed for a more granular approach to assessment. (This is available in Appendix 2 of the current report.) The graphics on the following pages should be read in conjunction with a description of what has and has not changed over the past year.

Economic risks: The main shift between the outlook in early 2007 and the outlook in early 2008 has been a major re-appreciation of risk over the course of 2007 as many of the mismatches highlighted in *Global Risks 2007* have begun to unwind. The trade-weighted exchange rate of the US dollar has fallen, and the risks of a further sharp fall have edged up. Oil prices have continued to rise to close to inflation-adjusted peaks –

increasing vulnerability to a supply-side shock – but the world has demonstrated remarkable resilience in absorbing higher prices. From a relatively positive picture of the stability of the world economy in early 2007, the world is entering 2008 under conditions of considerable economic uncertainty. The possibility of a US recession has undoubtedly increased, but there is considerable debate as to how this would impact global prosperity.

ECONOMIC

- Rising and volatile prices create significant shortages for poor people globally (those whose consumption basket is more than 50% food).
- Oil or gas prices rise steeply due to a major supply disruption (decreased global supply of 10% for several months).
- An abrupt, major fall in the value of the US dollar with impacts throughout the financial system.

- Domestic social/political issues combine to slow Chinese growth to 6% or less (sustained over time).
- Declining fiscal positions force multiple governments of wealthy countries to raise taxes, leading to economic stagnation.
- House and other asset prices collapse in the US, United Kingdom and continental Europe, reducing consumer spending and creating a recession.

Geopolitical risks: Geopolitical risks remain broadly divided into three categories: geo-economic, structural shifts and regional instability. On the geo-economic side the main risks are associated with a potential retrenchment from globalization, whether from growing protectionism in the developed world or from political pressures in the developing world. Political risk has returned to the management of the global economy in a major way in recent years, and that trend looks set to continue. In terms of structural shifts, the pressures for change on the post-1945 model of

global governance will continue to complicate moves to improve global governance of global risks, either in terms of security or management of financial imbalances. Finally, the focal points of global geopolitical risk – Afghanistan, Iran and Iraq – are likely to continue to engage the world in 2008. The possibilities for positive game-changing developments, such as peace between Israelis and Palestinians, are always present. But few experts predict that the geopolitical picture will change significantly for the better in 2008.

GEOPOLITICS

- International terrorists mount multiple attacks with conventional and chemical (but not nuclear) weapons, causing significant economic and human losses and exacerbating the retrenchment from globalization.
- Collapse of the Non-Proliferation Treaty (NPT) leads to multiple states simultaneously pursuing nuclear technologies and weaponization, with associated increase in geopolitical tensions dragging on the global economy.
- US/Iran conflict.
- US/Democratic People's Republic of Korea conflict.
- Nation building in Afghanistan fails, providing haven for international terrorist groups and triggering the decline of the Pakistani state.
- Disorder in the Horn of Africa worsens as multiple states descend into conflict and offer haven for terrorist groups.
- A fragile Latin American regime collapses suddenly, spreading political and economic uncertainty throughout the region.
- Penetration of organized crime in the global economy increases significantly over a 10-year period, weakening state authority, worsening the investment climate and slowing growth.
- Multiple developed economies take steps (tariffs, WTO disputes) which slow existing trade and further undermine talks on increased global integration.
- Multiple significant emerging economies advance policies that harm foreign direct investment and slow the engine of global growth.
- Worsening conflict in the Occupied Territories claims thousands of lives over a 10-year period, and exacerbates geopolitical tensions and economic decline throughout the region.
- All forms of violence in Iraq – sectarian, insurgent, terrorist – worsen and claim thousands of lives. Failure to achieve peace destabilizes the region on an ongoing basis.

Environmental risks: The main shift in understanding of environmental risk has been increased awareness of the potential consequences of climate change. The geophysical factors behind an assessment of likelihood and

severity of both tropical storms and earthquakes have not changed. In 2007, the world has experienced two “near misses” in terms of potential economically catastrophic inland flooding in northern Europe and eastern China.

ENVIRONMENT

- Extreme weather events linked to climate change will impact businesses and society at large (e.g. multiple tropical cyclones make landfall along the Gulf Coast, India, Bangladesh or China over a 10-year period).
- More frequent and severe heatwaves and droughts have harsh impact on agricultural yields around the world.
- Declining quality and quantity of water in several major watersheds leads to water shortages and increased prevalence of water-borne disease.
- Natural catastrophe: Category 5 tropical cyclone hurricane hits an economic centre such as Tokyo or southern Florida.
- Natural catastrophe: A strong earthquake hits an economic centre such as Tokyo, Los Angeles or San Francisco.
- Natural catastrophe: A strong earthquake or seaquake (followed by a strong tsunami) hits a developing country such as China, India or Indonesia.
- Natural catastrophe: Extreme inland flooding of the Mississippi, Yangtze, Thames or Rhine rivers causes direct economic and human losses and serious disruption downstream.

Societal risks: Increasing “globalization of risk” (see pages 27-29) may mean that the distinction between infectious diseases in the developing

world and chronic diseases in the developed world may be less operable, while the recognition of economic costs of both is rising.

SOCIETY

- A pandemic disease jumps from the animal population to humans, with high mortality and transmission rates.
- Incidence of infectious disease continues to rise in Africa and rises dramatically in Russia and South-East Asia (TB and HIV/AIDS).

- Chronic diseases are widespread in the developed world.
- US liability costs increase at four times the rate of GDP growth, and spread rapidly to Europe and Asia. Capacity for global insurance is reduced, undermining investment and growth.

Technological risks: Increasing human exposure to nanotechnology will increase severity should an event occur, but this has to be balanced against the multiple opportunities created by nanotechnology. The constant interplay of risks within the critical information infrastructure (complexity of systems, number of vulnerabilities, failure to effectively patch security holes, use of

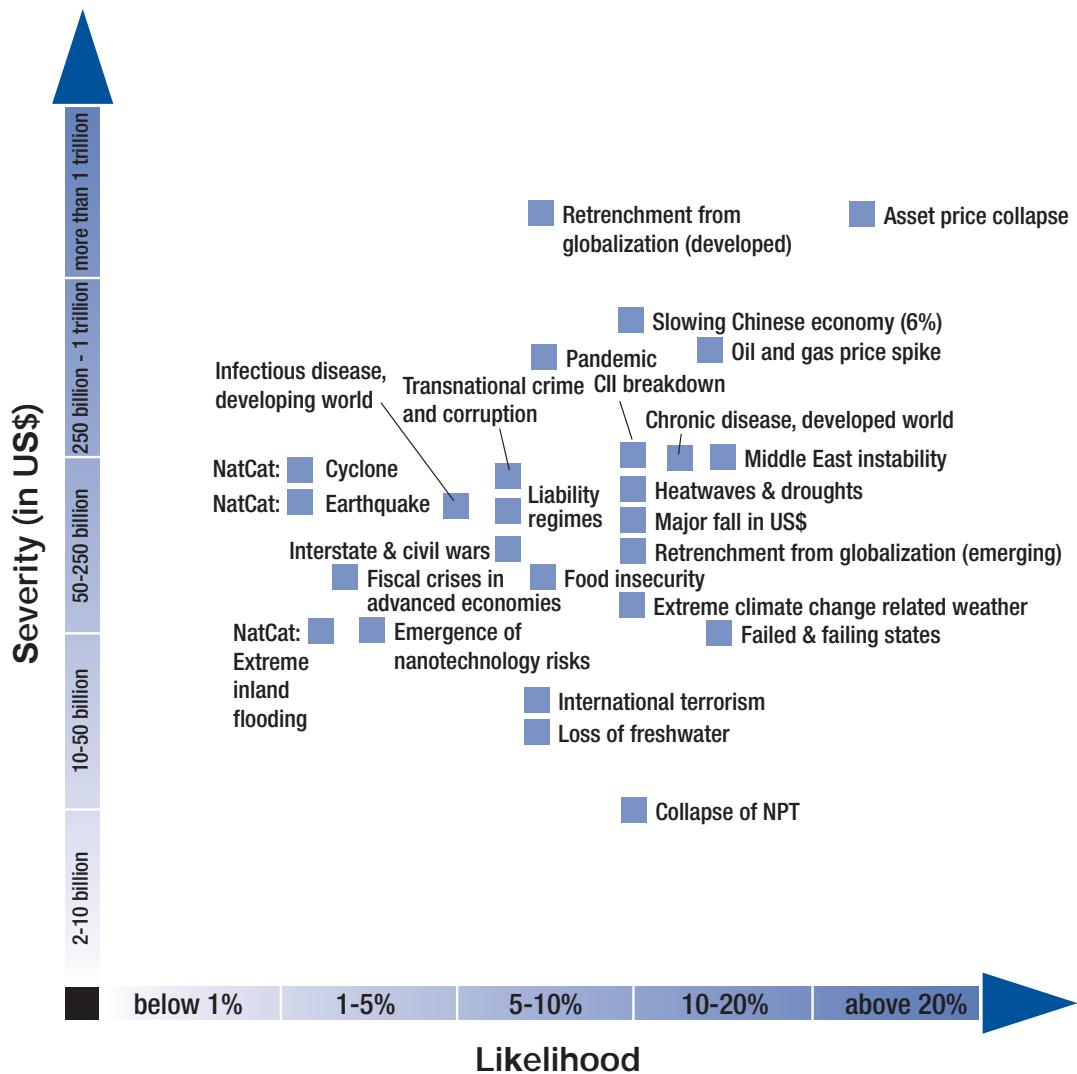
common – versus custom – applications) makes predicting specific attacks difficult, but there is increasing risk of attacks in general due to lack of resources devoted to cyber-security and constant probing of systems. In 2007, a growing number of electronic espionage attacks was considered to have been driven by foreign state authorities.

TECHNOLOGY

- Attack or system failure in critical information infrastructure (CII) creates a domino effect, shutting down IT-dependent applications in power, water, transport, banking and finance, and emergency management.

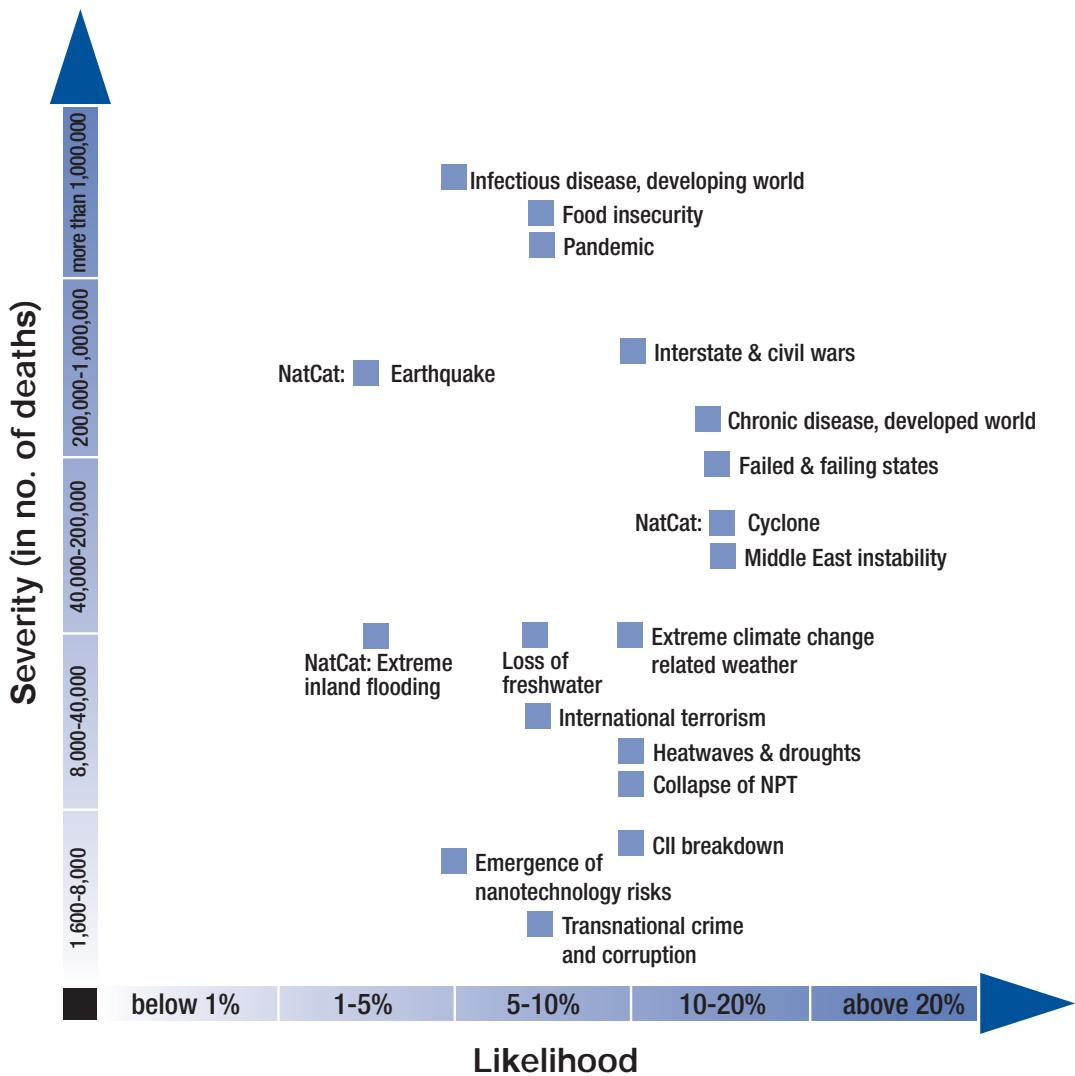
- Studies reveal health impairment due to exposure to widely used nanoparticles (paint, cosmetics, healthcare). Primary impact on public health and secondary impact on investment in a range of nanotechnologies.

The 26 Core Global Risks: Likelihood with Severity by Economic Loss



Note: Some risks were disaggregated for the purpose of assessment in Appendix 2 to the current report. For ease of visual representation they have been shown aggregated on the current graphics.

The 18 Core Global Risks: Likelihood with Severity by Number of Deaths



Note: Some risks were disaggregated for the purpose of assessment in Appendix 2 to the current report. For ease of visual representation they have been shown aggregated on the current graphics.

3. Networked World, Networked Risks

None of the global risks identified and assessed in this report manifest in isolation. Many are interconnected, not necessarily in a direct causative relationship, but often indirectly, either through common impacts or mitigation trade-offs. At each stage of the process of managing global risks, from identification and assessment to mitigation, an understanding of interconnectedness enhances the approach taken.

- 1. Risk identification** – identifying indirect exposures and potential tight couplings to exogenous risk events (shocks)
- 2. Risk assessment** – accommodating the reality of risk conflation whereby risks are rapidly transmitted across geographical, industry and company boundaries
- 3. Risk mitigation** – moving from managing risk in isolation (ring fencing) to addressing the transmission channels of risk (which may require collaborative action) as well as considering second and third order effects

Understanding the interconnected nature of global risks is methodologically and conceptually complex. Yet, if an understanding of interconnectedness is to be integrated into prioritization and decision-making at the level of government, business and international organizations, representing complexity is crucial. Bringing together expert views on how to think about interconnectedness is an ongoing mission of the Global Risk Network to exchange ideas and methodologies.

One approach, pursued for the *Global Risks 2007* report and continued in this report, was to build a picture of correlation of core global risks through an ongoing survey of independent experts. In 2007, this resulted in a matrix of correlation between the core global risks.

The approach has both strengths and limitations. First, the matrix measures strength of correlation, rather than pathways of causation. Correlation can tell us that risks manifest together, but it does not tell us how and why. As a result, correlation may provide as much "noise" as "signal". Second, the matrix provides a useful measure of "static" interconnectedness, providing an overview of potential linkages between risks, but not an



"Interdependence is the defining issue of the 21st century."

Tony Blair, Prime Minister of the United Kingdom (1997-2007); Member of the Foundation Board of the World Economic Forum (January 2007)

understanding of their dynamic interactions over time. Third, the correlation approach only considers positive correlations, excluding negative correlations (such as the potentially negative correlation between risks related to climate change and the risk of sustained high oil prices) which may also inform the appropriateness of mitigation policies.

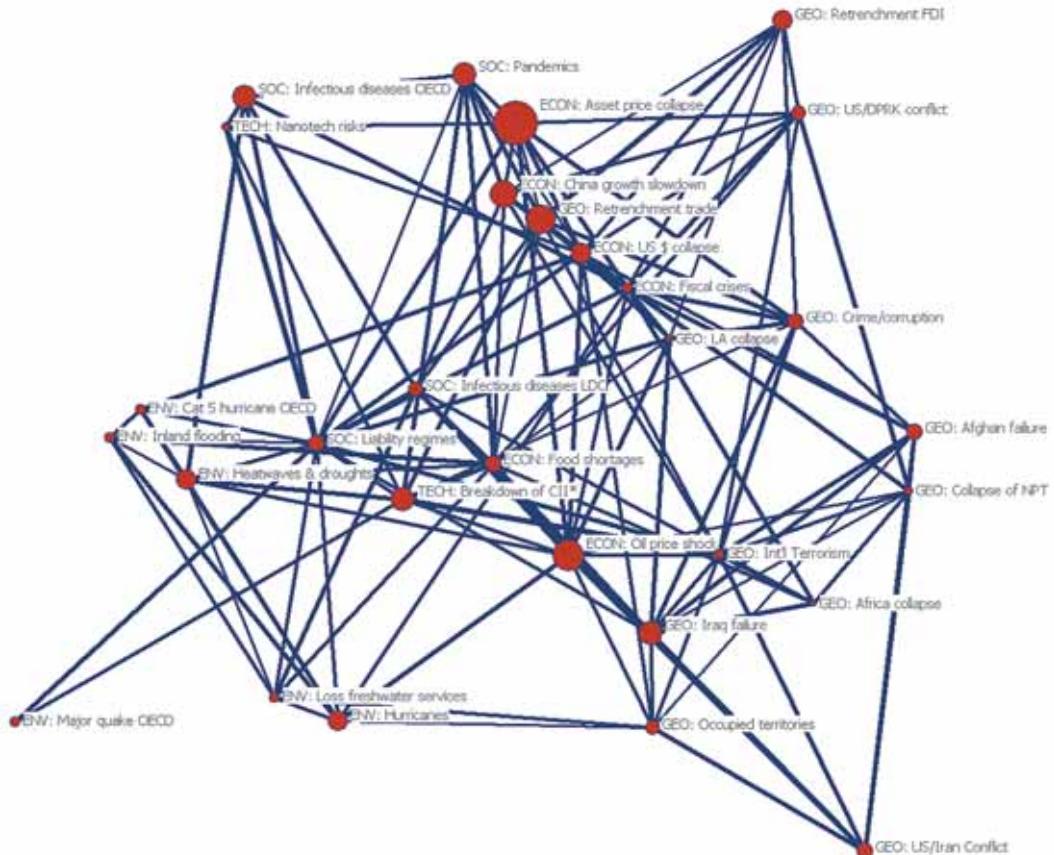
For the 2008 report, the Global Risk Network considered the application of social network analysis to understand correlation between global risks, constructing a network diagram with nodes denoting individual global risks and ties showing the strength of correlation between the risks. Rather than treating risks as discrete units of analysis, the focus is on how the structure and ties affect risk transmission.

There are three dimensions of risk rendered by the map: the size of the nodes denotes the severity of

the risk; the thickness of connecting lines reflects the strength of correlation; and the spatial proximity of the nodes is based upon similarity in risk correlations. The last dimension ensures that risks with similar bivariate correlations are clustered close together, reducing the ratio between "noise" and "signal" compared to the correlation matrix produced for *Global Risks 2007*.

The correlation map highlights the different ways in which risks can be interconnected, adding to the understanding of assessment and potentially providing input into stress test simulations and scenario processes. The correlation map may also provide a proxy for understanding some of the mechanisms of risk transmission. A secondary analysis of "pivotal nodes" was conducted, based on Monte Carlo simulation techniques, which identified the risks that are most critical to the diffusion of global risk through the system. On the

Social Networking Diagram of Global Risks



Note: The sizes of the nodes in the social networking diagram indicate the assessment of the risk itself. The thickness of lines represent strength of correlation, while proximity of the nodes represents similarity of correlations
Source: Witold Henisz, Associate Professor of Management, The Wharton School, University of Pennsylvania, USA, based on expert assessments of correlation (October 2007).

basis of the responses to the current survey, the top four risks are food (in)security, an abrupt fall in the US dollar, international terrorism and a US/Iran conflict.

In 2008-2009 the Global Risk Network will work to expand an understanding of correlation and causation by bringing together experts on these issues from public and private sectors.

The globalization of risk

Interdependency implies that we are all vulnerable to disruptions in the global flow of people, capital and technology. But there are at least two additional elements to the globalization of risk which may broaden our understanding of the mechanics of interconnectedness in the global risk environment.

The first is risk "squeezing": the transfer of negative externalities of a production process, such as environmental and human costs, from one area to another. In recent years, this has happened on a massive scale as a result of economic globalization, raising a number of dilemmas for effective and equitable global governance of risk. The first is that shifting production to less regulated geographies may, in itself, increase the aggregate negative externalities associated with that production. The second is that the transfer of risk may, in any case, be an illusion if the negative externalities affect the global system as a whole, or if other costs may be re-imported in other forms. The globalization of capital has so outpaced the globalization of governance that returns to capital have been decoupled from environmental and other costs.

The second is risk "homogeneity". For example, chronic diseases, such as heart disease, cancer and diabetes, traditionally considered to be problems of the developed world, are becoming common in developing countries. As lifestyles become increasingly convergent globally, the trend towards similar risk profiles is likely to continue. Another example is global pandemics. One consequence of this growing risk homogeneity is that the case for common and coordinated global mitigation action has strengthened. In section 5 of the current report, we look at how a region-at-risk model may be used

to identify potential coalitions of actors around global risk issues and how a forum of country risk officers could provide a mechanism for coordinating the mitigation of global risks.

Risk squeezing

High labour and social costs, and tougher environmental legislation in the developed world, coupled with historic reductions in barriers to international trade, have moved economic production from a national to a global basis. Supply chains have become more complex – see section 1 – and the full exploitation of differences in comparative advantage has unlocked global economic growth.

One result has been a delocalization of risk. Even as primary risks in production are reduced in one location, those risks may be "squeezed" to new centres of production where costs, standards and conditions are lower. Some of the effects of risk squeezing may remain in geographies of production, posing an ethical dilemma at the heart of globalization.

But other effects of risk squeezing may have wider global consequences.

First, and most clearly, risk squeezing simply displaces the original source of risk, but without mitigating the systemic consequences of risk and, occasionally, worsening both the underlying risk and aggregate systemic vulnerabilities to it. One clear example of this is in environmental matters: improving environmental regulation may reduce environmental costs in the near term, but if regulation pushes production to a less-regulated geography which is less equipped to deal with its consequences, then the aggregate long-term impacts may be worse.

For example, developed country measures to reduce carbon emissions will not be meaningful in the absence of global frameworks and action. Yet the lack of a global price for carbon means that economic incentives to enhance carbon efficiency or produce in more carbon-efficient geographies are not there.

But the principle of risk squeezing in the environmental context also applies to air and water pollution. While air and water quality have improved drastically in recent decades in developed countries, quality elsewhere has been declining – calling into question the long-term, risk-adjusted sustainability of economic growth. Moreover, some of these problems are easily exported. A toxic spill in a river from a factory in China could pollute agriculture through irrigation, enter into the production of goods for global export, and even threaten the water supply of a major Russian city. Environmental degradation may ultimately lead to political unrest, both locally and across borders. Such a problem requires, at a minimum, a bilateral agreement and frequently global standards of production or pollution control.

Second, as semi-finished or finished products are exported, the effects of “risk squeezing” may be felt in less obvious and less controllable ways, with major consequences in importing countries. In 2007, the discovery of toxic chemicals in children’s toys, made in China for an American brand name, made consumers aware of health risks in imported

products which they had previously not considered. The companies involved suffered both a reputational hit and major economic losses.

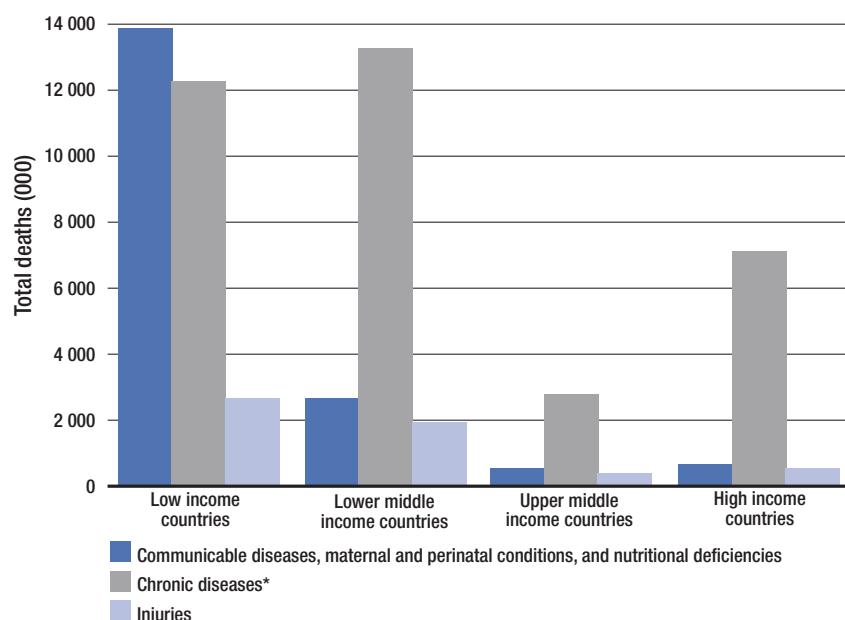
Third, the perception of lack of transparency in production processes and supply chains may undermine popular support for globalization. The argument for consumer protection can lead to outright economic protectionism, going far beyond the genuine risks and beyond the original product or geographic source of risk.

Risk homogeneity

While specific vulnerabilities will remain, interconnectedness, globalization and the spread of similar economic and social structures may generate a degree of homogeneity of risk at the global level.

One example of this is in health risks. Just as globalization has increased the commonality of habits and lifestyles, so has it raised the homogeneity of the risks associated with those lifestyles. Non-communicable diseases, such as

Projected Deaths by Major Cause and Income Group, All Ages, 2005



Note: *Chronic diseases include cardiovascular diseases, cancers, chronic respiratory disorders, diabetes, neuropsychiatric and sense organ disorders, musculoskeletal and oral disorders, digestive diseases, genito-urinary diseases, congenital abnormalities and skin diseases.

Source: © Copyright World Health Organization (WHO), 2007. All Rights Reserved.



cardiovascular disease, cancer and diabetes which are traditionally associated with a Western lifestyle, have rapidly become prevalent in the developing world as lifestyles have moved more towards urban and less physically active jobs. Ironically, as people live longer, they are now suffering from these diseases. Another negative habit is the increased use and consumption of tobacco, alcohol and unhealthy foods. Companies confronted with taxes and regulations against these products in the developed world now target new consumers in the developing world. Finally, global travel patterns have made the risk of a pandemic homogenous across the world. All countries are equally vulnerable to a pandemic that originates in one country.

According to the World Health Organization, chronic diseases are worst in low- and middle-income countries where 80% of non-communicable disease deaths occur, and are now widely considered – against the perceptions of many developed countries – to be the poor nation's major health problem, with the notable exception of African countries, where deaths from infectious disease remain higher.

The policy conclusion: global cooperation is required

To address externalities at the global level and the increased homogeneity of global risks, international cooperation is a necessity. One potential forum for such cooperation would be an annual meeting between country risk officers where they could review global risks and mitigation strategies. Problems between individual countries could be dealt with on a bilateral basis.

4. Financial Markets, Risk Transfer and Risk Mitigation

Financial markets are increasingly seen as a major tool of the transfer and mitigation of an increasing variety of global risks. Insurance and reinsurance have traditionally been the key to management and mitigation of risk, and the principles which allow for maintaining both economic efficiency and social equity will be key to maintaining the healthy role of insurance and reinsurance in the future (see box on page 34) on insurance and risk mitigation lessons derived from the US experience of natural catastrophe insurance).

The growth of financial markets has opened up the possibility of using markets to help mitigate non-traditional risks (see box on this page) the possible use of financial markets to reduce the risks from nuclear non-proliferation). Also, the rapid emergence of a new market in insurance-linked securities is helping to cover peak risks, which cannot be currently covered adequately by traditional insurance and reinsurance. In some cases, financial markets are principally acting as a vehicle of risk transfer. In other cases, accurate pricing of risk may be helping to drive mitigation of the primary risk.

This section of the report explores some of those developments and asks how effective they can be in the future. The first part reviews a proposal of how financial markets may help mitigate a non-traditional risk: nuclear proliferation. The second describes how the expansion of insurance-linked securities and other financial instruments are being used to increase risk transfer, diversify risk into capital markets and increase the pool of capital available for insurance. A final part examines how an in-depth study of insurance dealing with natural catastrophes in the US may have broader application to how we think about the management of global risks.

Energy, security and nuclear non-proliferation: How private markets can help

The nuclear renaissance

Concerns over climate change and long-term energy security have put nuclear power firmly back on the 2007-2008 global agenda. As a non-carbon-based energy source with a much-improved safety record since the Three Mile Island and Chernobyl disasters, nuclear technology has a number of attractions in an era of uncertainty.

Many of the nuclear power plants planned or currently under construction – a total of over 300 – are in countries that already have a functioning nuclear industry: Europe, the US, China, India and Russia. But a growing number of non-nuclear technology states are exploring the nuclear power option: Turkey, Vietnam and Egypt, among others.

The problem is that nuclear power relies on access to enriched uranium. Some countries exploring a national capacity for nuclear energy fear that they could be blocked in the future by the six states which currently produce enriched uranium on a commercial basis: France, Germany, the Netherlands, Russia, the United Kingdom and the US. To avoid this, they may decide to build their own uranium enrichment facilities. But were this to happen, the international structures governing nuclear technologies would be shattered, and the risks of wider proliferation would rise dangerously.

The economic/security trade-off

Given that the same process used to enrich uranium for fuel in power plants can also produce weapons-grade nuclear material, the only way to reduce the risk of proliferation of weapons-grade material is to dissuade states from building new enrichment facilities.

But, were the international community to credibly ensure reliable supplies of uranium-based fuel for power generation for all countries, the incentive for any one country to build new enrichment facilities would be removed.

Turning the risk of the spread of nuclear technologies into an opportunity to create a sustainable framework for the production of safe, clean and secure electrical power should be a major objective of global policy. The innovative use of financial markets may offer a way to achieve it.

The innovation: “insure to assure”

The International Atomic Energy Agency (IAEA) and governments have been grappling with this dilemma for years. Various mechanisms to assure states’ access to enriched uranium without political interference have been considered. But some fear that any IAEA solution remains susceptible to political pressure from producer members.

A truly innovative concept has been proposed by a joint team from the Wharton Business School and Harvard’s Kennedy School: “insure to assure.” The proposed solution – complementary to the efforts of the IAEA and others – would create a partnership between financial industries and governments to create the world’s first international nuclear fuel insurance fund.

The fund would operate as follows: Premiums, collected from all member countries, would be deposited in a mutual insurance company (MIC) which, in turn, would use some of the money to build a cash reserve and to purchase supply options. Residual funds would go to a consortium of insurers and reinsurers that would provide layered financial protection to all participating

countries. The IAEA member governments would serve as a financial backstop for the consortium. In the event of a fuel disruption, the MIC would exercise its options and work with fuel suppliers, energy producers and transporters to arrange timely fuel delivery or alternative electricity purchases off the energy grid (if available). The insurance consortium would compensate member countries and others involved in replacing fuel for any loss of efficiency as previously contractually agreed.

The concept is based on a key principle of mitigating global risks: while everyone is looking to ensure energy security through energy *independence*, the “insure to assure” concept might help improve energy security by creating a clear framework for “energy *interdependence*.”

There are a number of classic global risk questions on the financial market response to nuclear proliferation – among them issues on moral hazard and joint liability – and certainly this concept could not be expected to be effective in the absence of a concerted policy in other areas and trust in the integrity of the system. However, the power of financial markets, as a complement to other measures, is often under-appreciated.

Implementation: nuclear and beyond

The proposal, which is now being studied by different stakeholders, would bring together two worlds that rarely talk to one another: the worlds of international security and international finance. As it stands, the proposal only deals with nuclear fuel supplies, but there is no reason why a larger mutual insurance company could not help turn wider global energy interdependence from a source of perceived vulnerability to a source of systemic coherence and security.

Insurance-linked securities: how much can financial markets diversify risk?

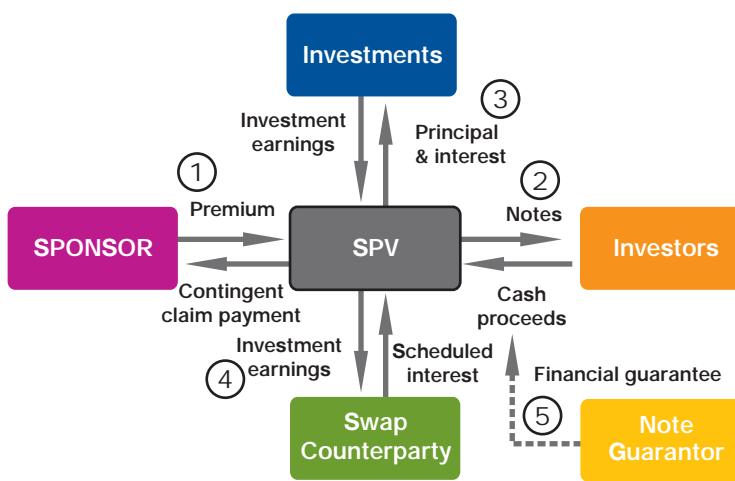
The process of pooling risks and dividing that pool into portions sold to a wide range of investors on the secondary market – known as securitization – has expanded massively in recent years. Securitizations now account for one-third of the US fixed income market. Transactions that were once considered highly innovative are now mainstream.

More recently securitization has spread to insurance, as insurers have transferred their risks to capital markets through securities' issues. The result has been a diversification of risk for insurers and an increase in the pool of capital available to cover insurance risks. The use of financial markets to raise insurance capital is not without potential drawbacks: systemic risk could eventually be created by insurance-linked securities. However, these potential constraints on securitization are far into the future. Currently, the relatively small size of the insurance-linked securities market and a growing understanding and sophistication of insurance-linked securities suggest considerable scope for financial market diversification of an increasingly broad set of risks.

The market in insurance-linked securities initially developed in response to insurers' capital requirements in covering four traditional "peak" risks: windstorms in Europe, earthquakes in Japan, hurricanes in the US and earthquakes in California. After Hurricane Andrew in 1992 the price of catastrophe risk coverage rose considerably and coverage became increasingly scarce. Insurance-linked securities covering catastrophe – so-called "cat" bonds – provided additional capital to the insurance industry, helping it to manage catastrophe risk and prepare for the next major event. Presently, catastrophe bonds are issued to cover a range of non-peak risks, from Mexican earthquakes to floods in the United Kingdom.

Subsequent transactions have further broadened insurance-linked securities. In January 2006, Swiss Re securitized US\$ 252 million of credit risk linked to claims and reserves on its credit reinsurance business for underwriting years 2006 through 2008. Catastrophe securitizations – or mortality bonds – can also be used by insurers and reinsurers to hedge against the risk of increased death rates caused by a major global risk (such as a pandemic or a major terrorist attack). In all of these cases,

Typical Cat Bond Structure



- ① The Sponsor enters into a financial contract with a Special Purpose Vehicle (SPV)
- ② The SPV hedges the financial contract by issuing Notes to investors in capital markets
- ③ Proceeds from the securities offering are invested in high quality securities and held in a collateral trust
- ④ Investment returns are swapped to a LIBOR-based rate by the Swap Counterparty
- ⑤ In some transactions, principal and interest on the Notes may be guaranteed by a Note Guarantor

Source: Swiss Re

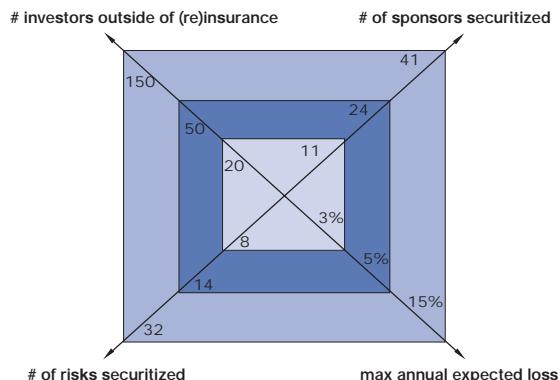
securitization improves the diversification of risk and, therefore, the risk-bearing capacity of the insurance system. As securitization grows more cost effective, insurers will be able to increasingly share cost benefits, contributing further to the risk transfer market.

Insurance-linked securities have grown considerably in recent years in terms of depth, breadth and overall market capacity (see figure below). For investors, insurance-linked securities are attractive as they provide an investment in a specific insurance risk with potentially low correlations with equity and credit markets, and with a reduced counterparty risk because some funds can be held in trust.

Other insurance-linked financial instruments

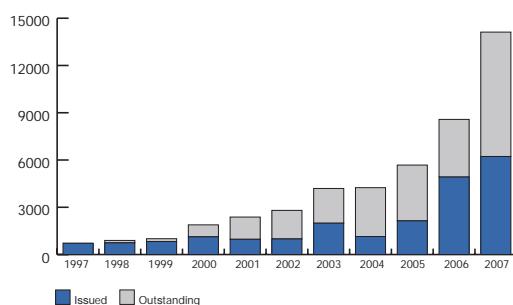
Besides insurance-linked securities, a wide variety of derivatives and other financial instruments are now being used to transfer insurance risks. The market for weather derivatives is large, growing rapidly and fairly well known. Most of these derivatives pay out when the weather is exceptionally warm, or exceptionally cold. They are also promoted in emerging markets to reduce agricultural income volatility. In addition, the market for over-the-counter industry loss warranties is growing. These instruments provide protection against US hurricanes and are triggered

Significant Increase in Market Depth and Breadth

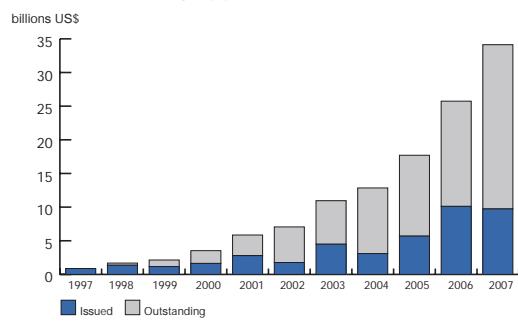


Note: The increasing threshold of annual expected loss, the range of different risks being securitized and the number of sponsors involved in securitization of insurance-linked securities indicate the growing maturity of insurance-linked securities, and the market appetite for them
Source: Swiss Re

Total non-life bonds outstanding, by year



Total ILS outstanding, by year



Note: New issuance in 2007 (to November) had already exceeded that of 2006. Total non-life bonds outstanding totalled approximately US\$ 14 billion. Fourth quarter 2007 also saw over US\$ 600 million of extreme mortality cover placed. Total bonds outstanding exceeded US\$ 34 billion
Source: Swiss Re

when insurance industry losses for a particular hurricane are high. Also in the US, the Chicago Mercantile Exchange and the New York Mercantile Exchange are attempting to establish exchange-traded derivatives that provide protection against hurricane losses. Finally, there are a wide variety of customized derivatives, providing protection against losses from earthquakes and typhoons in Japan, earthquakes in Turkey, excess mortality losses, aviation peril, etc. All of these instruments are arranged by (re)insurers, brokers and banks for companies and insurers, with protection provided by capital markets – often hedge funds that specialize in insurance risks.

Applying the "5i" framework to financial risk transfer instruments

Applying the "5i" framework of risk mitigation to insurance-linked securities yields an analysis of the strengths, weaknesses and requirements of insurance-linked securities in global risk mitigation.

- **Insight:** Broader and deeper markets should motivate a more sophisticated understanding of the drivers and impacts of risks – for example, the inclusion of capital market investors in a pandemic risk transfer might heighten awareness of the correlation between extreme mortality risks and economic risks.
- **Information flow:** Broadening of markets should improve the quality and flow of information about risks – and should encourage transparency in the reinsurance industry.
- **Incentives:** Accurate pricing of risk transfer instruments should, in principle, act as an incentive for ex-ante mitigation measures and even, where appropriate, risk avoidance.
- **Investment:** Using financial markets increases the pool of investment available to indemnify the consequences of global risks.
- **Institutions:** Financial markets require strong public institutions to allow the market to flourish. These institutions and financial markets are in a symbiotic relationship. Efficient financial regulation and a secure legal environment for insurance-linked securities is a prerequisite to their expanded use, and to help improve global risk mitigation. Should transaction costs prove too high, the range and scope of the market will be constrained.

Insurance and risk transfer: lessons from natural catastrophe insurance in the US

Natural catastrophes have had a greater nominal US dollar impact on insurers over the past 15 years than in the entire history of insurance. Hurricane Katrina alone cost insurers and reinsurers an estimated US\$ 45 billion, while losses paid by private insurers due to major natural catastrophes in 2005 totalled US\$ 83 billion.

A significant part of the increase in natural catastrophe damage is due to increased construction in hazard-prone areas in recent decades, but there may be a longer-term driver as well: global warming may be resulting in increasing frequency of severe storms in certain parts of the world. While new construction in hazard-prone areas could be easily reduced by government regulation, the inertia effect of historical carbon emissions means that global warming will continue for decades, even if the future rate of warming may eventually be slowed and reversed by concerted international action.

Yet, insurance can help manage the impact of this risk in two important ways: directly, by providing financial protection to businesses and individuals against losses from catastrophic events and indirectly, by encouraging risk mitigation measures through lower premiums for those who invest in risk-reducing measures. In principle, insurance, by basing its prices on the risk of losses, can provide a strong incentive for improved risk management. In addition to serving an important social function, insurance can create the conditions for efficient economic allocation of resources. Often, however, the politics and economics of insurance clash.

Insurance will only be provided if premiums reflect actuarial risk: the insured damage resulting from a specific event, weighted by the probability of that

event occurring. Natural disasters cannot be prevented, though reducing climate change in the future could limit the increases in intensity and frequency of some natural catastrophes. Actuarial risk to individual properties can be reduced by fortifying them, and aggregate risk can be lowered by decreasing construction in vulnerable zones.

Developing guiding principles

Two guiding principles for using insurance and other financial instruments to effectively mitigate risk have been developed by the Wharton Risk Management and Decision Processes Center in the context of a research project on "Managing Large-Scale Risks in a New Era of Catastrophes".

- *Principle 1 – Premiums Reflecting Risk:* Insurance premiums should be based on risk, to provide signals to individuals as to the hazards they face and to encourage them to engage in cost-effective mitigation measures to reduce their vulnerability to catastrophes.
- *Principle 2 – Dealing with Equity and Affordability Issues:* Any special treatment given to residents currently residing in hazard-prone areas (e.g. low-income homeowners) should come from general public funding and not through insurance premium subsidies.

Mitigation

Economic analysis of case studies in four hurricane-vulnerable US states revealed that a range of physical mitigation measures – such as storm shutters, roof anchors and safety film on windows – could reduce insured losses from a severe hurricane considerably (by up to 61% in Florida).

But property owners rarely make these voluntary investments because they believe that catastrophes will not happen to them, and

because the economic incentives to invest are suppressed by artificially low premiums.

In a survey of those living along the US Atlantic and Gulf Coasts, undertaken in the spring of 2006, 83% of respondents had taken no steps to fortify their homes with relatively inexpensive measures, even after the devastating 2004 and 2005 hurricane seasons.

Lessons for global risk management?

What lessons can be drawn from US natural catastrophe insurance to understand the role of insurance in managing global risks?

- First, understanding the nature of the risk and quantifying it is the prerequisite for insurance.
- Second, there is a need for new risk transfer instruments such as catastrophe bonds and other financial instruments, which can supplement traditional reinsurance, to enable insurers to protect themselves against catastrophic losses and reduce the need for government intervention.
- Third, insurers need to be able to charge a premium that reflects the risk they assume and which rewards those who undertake mitigation measures. Government intervention to artificially suppress premiums may have unintended consequences, including reducing the economic sustainability of insurance by skewing incentives. However, government codification of mitigation measures may help.
- Finally, the way in which equity concerns are met is vital. It would be more efficient to provide insurance vouchers and mitigation grants to low-income groups in the US living in natural catastrophe zones, than to mandate artificially low insurance premiums. Similarly, addressing equity issues at a level should not be done in a way which reduces the ability to leverage financial markets to mitigate risk.

5. Structuring Mitigation at the State and International Level: Taking the Country Risk Officer Forward

In *Global Risks 2007*, the Global Risk Network introduced the concept of the country risk officer as a public sector equivalent to corporate risk officers in the private sector, who are growing in importance. Given the complexity and correlations of risk, possible trade-offs across government department silos, and the agreed need for better communication between the public and private sector, managing risk on a portfolio basis is as important in government as it is in the private sector. More importantly, identifying a common language of risk and risk assessment across the public and private sectors may make it easier in the future for both to cooperate in mitigation initiatives.

For *Global Risks 2008*, the Global Risk Network convened an informal group of experts to explore the country risk officer concept, to understand its limits and its strengths and to begin to understand what principles of best practice could be developed to guide country risk management.

It was concluded that the country risk officer was not necessarily a single role to be held by one individual – it might be a committee, a process, or multiple coordinated positions. Much would depend on the specific political and economic structures in which the concept of country portfolio risk management is applied – a centralized system such as the United Kingdom or a federal system such as Germany or Switzerland would necessitate very different structures to achieve a similar objective.

It was also agreed that, while an individual country risk officer in one country might vastly improve understanding and coordination of risk on the national level, many global risks require an inherently international response. A forum of national country risk officers might be one way of achieving common assessment, trust and institutional confidence to enable much improved management of global risks when they manifest across international borders.

Currently, government bodies play a four-part role in risk management at the national level.

- **Action:** from identification of risks to crisis management and risk communication
- **Regulation:** the use of legislation to help prevent the emergence of risks and to protect against the consequences of risks should they arise

- **Economic continuity:** the use of measures (such as release of financial reserves or strategic energy reserves) which ensure economic robustness in the face of a wide range of risk events
- **Insurance:** acting as an insurer of last resort

Global risk, government and business: different incentives, different goals, common opportunities

The incentives for business and government in risk mitigation are different:

- Doing business involves taking risk; government largely avoids risk.
- While businesses aim to maximize profit and shareholder value, both relatively easily measured metrics, governments seek to satisfy a much broader set of stakeholders, with far more complex trade-offs.
- Government assessments of global risk are necessarily idiosyncratic in that they consider stakeholder concerns differentially – but they must obtain broad legitimacy to be considered as a basis for action.

However, opportunities exist for collaboration between government and business on developing and sharing common methodologies.

The group established five principles of country risk management which could be applied across the spectrum of governments to guide country risk officers, whether the officer is an individual, a coordinating committee or takes some other institutional form.

- **Accountability:** The need for accountability of risk assessment is seen as a fundamental condition of the legitimacy of assessment as a basis for concerted government action both vertically (within departments of government) and horizontally (across branches of government). Clarity of accountability would increase the incentives for effective mitigation measures.
- **Integrated assessment:** Establishing common procedures across government departments to assess risks, cross-disciplinary scenarios and the

language of risk would provide a basis not only for better crisis management but also for defining more effective prevention and mitigation of global risks. Too often positive externalities are overlooked and negative externalities are exaggerated by lack of an integrated assessment of risk.

- ***Devolved implementation:*** Integrated assessment should not imply centralized implementation. Devolved implementation of risk mitigation strategies should allow flexible and adaptive responses to common risks.
- ***Separation of analysis and policy:*** The case for devolved implementation is strengthened by the argument in favour of separation of analysis and policy. Analysis is better kept within a separate structure, so as to prevent bureaucratic pressures impinging upon independence of analysis.

• ***Disclosure and transparency (if possible):***

Governments are constantly caught between pressure to disclose risk assessments and the need to keep some assessments confidential so as to avoid panic, protect sources and maintain resilience. But even the maintenance of confidential information can create the conditions for incomplete or inaccurate information leading to an “infodemic” situation in a crisis, where the consequences of popular reaction to a perceived risk far outweigh the risk itself. The development of much more granular risk communication strategies will ensure a culture of maximum disclosure and transparency, while safeguarding against information overload.

Region at risk: A basis for identifying international risk mitigation coalitions?

An additional institutional innovation suggested in *Global Risks 2007* was the creation of an “avant-garde of relevant governments and companies around different global risks.” The report argued that the urgency, complexity and multiple trade-offs in global risks require structures which can respond flexibly, assemble quickly and achieve legitimacy through success. “A process of gradually expanding alliances rather than a proposition requiring permanent consensus” may offer a better way forward.

But, even under conditions of extreme interdependency, the problem of mobilizing collective action to mitigate global risks remains. One strategy to activate coalitions to mitigate global risks may lie in an improved understanding of national risk exposures and identifying clusters of countries that are exposed to the same risks in similar orders of magnitude.

The region at risk model, which will be developed in 2008-2009, will achieve this by drilling down into the frequencies and severities of global risk at the national level, gathering expert input on country risk exposures, and creating a framework which is compatible with the global approach taken in previous Global Risk reports.

Individual countries can then be represented by a specific set of risks, and an aggregate risk measure can be derived that allows for cross-country comparisons. Cross-correlations, which account for different causal relationships among the various global risks, complete the country model. The more interesting features will derive from the model’s capability to integrate a wealth of data, account for cross-correlations among risks, analyse specific vulnerabilities, identify country clusters, engage in what if scenarios and, ultimately, point to potential coalitions of countries to mitigate risk.

The country risk officer: an example from the United Kingdom

As discussed above, the country risk officer is not necessarily a single individual. It may equally be a cross-government process, a secretariat, a function within different ministries, or a combination of all three. The common principles for effective country risk management identified above may take a variety of institutional forms.

One of the pioneers in coordinated risk management is the United Kingdom, which set up the Civil Contingencies Secretariat (CCS) in 2001 initially to improve the effectiveness of post-crisis management, but increasingly to play a more forward-looking role in identifying and assessing potential risks to national resilience. The CCS provides a single framework for government actions to absorb, respond to and recover from disruptive challenges, but serves a number of different functions: establishing the risk landscape facing the United Kingdom, improving consistency across government in terms of assessment and management of risks, clarifying roles and responsibilities and providing a basis for effective performance management.

One of the key problems within government in terms of risk management in general has been the existence of either horizontal disconnects between levels of government, or vertical disconnects between departments of government. In some countries the response to interconnectedness of global risks has been to merge existing government departments with existing operational responsibilities, with varying degrees of operational success. The CCS, in contrast, is a relatively new and relatively small entity at the centre of the United Kingdom government (the Cabinet Office) designed to act as a focal point within government for identification, assessment and management of risk, and as an entry point for dialogue with the private and voluntary sectors, as well as with the public sector at local, regional and national level.

The keystone of national risk management in the United Kingdom has become the annual national assessment process on an all-hazards basis to identify, describe and quantify risks which may impact the resilience of the country, looking forward over a five-year period. Identification, analysis and prioritization of risks are placed ahead of measuring capability gaps, so as to avoid a retroactive fitting of risk identification on existing government structures. The widest possible range of government agencies is involved in identification and description of the national risk landscape, so as to ensure a comprehensive list of risks and enhance a common understanding of global risks facing the country.

At the assessment stage, the same method is used to measure the severity of all risks while two approaches can be taken to quantify the likelihood depending on whether the risk is considered a natural hazard and, therefore, more amenable to objective measurement on a historical or scientific basis, or a threat of malicious harm for which objective assessments have to be blended with more subjective judgement. In both cases, however, the end result is an estimation of the likelihood and severity of plausible worst-case scenarios which allow for comparison and prioritization across risk categories. The highest rated risks are then considered in terms of their generic and specific consequences and whether, at the local, regional or national level, government plans, infrastructure, equipment, legislation, supplies, doctrine and training are adequate to manage and mitigate them. The CCS coordinates capability enhancements where this is not the case.

This approach is thought to be effective in prioritizing and quantifying the risks to homeland security – broadly defined – needing to be dealt with. It is too early to conclude the effectiveness of the CCS approach in improving the United Kingdom's ability to manage global risks. But one obvious constraint is the lack of obvious interlocutors in other countries, despite the transnational and interconnected nature of many of the risks which the CCS identifies and assesses.

6. Conclusion

This year it will be difficult to manage global risks. Both political and economic uncertainties are likely to act as a focus for global discussion and energy. On the economic side, an exceptional period of global growth may come under pressure as the liquidity crisis of 2007 impacts the real economy. On the political side, changes of government in several major countries and an uncertain situation in the Middle East will dominate. Leadership on global risk issues will be an increasingly precious commodity.

As this report has indicated, some progress on understanding and managing global risks is taking place. Opportunities for a peaceful settlement in the Israel-Palestine conflict may be stronger in 2008 than at any time since the turn of the century. Major emerging economies have increasingly demonstrated their willingness to take a leadership role in managing global risks. New financial products may be increasing the potential of financial markets to diversify and absorb risk. Risk management has become a key element of the management and strategy of both business and government. Recognition of the need to reform the global energy economy has set the stage for a multi-decade shift in direction.

But, for many of the global risks discussed in this report, the question of ownership of these risks remains unanswered. The fragmentation of ownership of global risks and the complexity of interdependencies will make equitable and sustainable management of global risks hugely challenging. Should systemic financial risk lead to a serious deterioration in the world economy, the prospects for collaborative mitigation may be reversed on several fronts simultaneously as attention turns to more immediate concerns.

The Global Risk Network will continue to bring together policy-makers, business leaders and non-governmental organizations to help align assessments of risk, to understand institutional gaps and to better grasp the interconnectedness of sectors and risks.

Appendix 1: Taxonomy of Global Risk: Trends, Issues of Concern, Risks

In 2007-2008 the Global Risk Network identified trends, issues of concern and risks. Trends are observable facts in the contemporary world. Issues of concern are potential challenges which arise from those trends. The risks identified are specific realizations of those challenges in a format which is sufficiently specific to be open to a level of assessment in terms of relative severity and likelihood, without being so specific as to preclude them as a basis for decision-making.

The probability of a specific scenario occurring reduces as the parameters of the scenario become more described. But scenarios with negligible probability are unlikely to be a firm basis for decision-making. A balance is therefore required between specificity and generality.

In some domains the path between trends, issues and risks is clear. In others, notably geopolitical risk, the pathway from trend to risk is less clear, contingency is greater and common issues can manifest in many different ways.

1. Economics – 6 trends, 6 issues of concern, 6 risks

- 1.1. Trend: Growing imbalances in food/agricultural production and use, driven in part by biofuel production and a shift to water-intensive crops
 - 1.1.1. Issue of concern: Rapidly rising and increasingly volatile food prices
 - 1.1.1.1. Risk: Rising and volatile prices create significant shortages for poor consumers globally (those whose consumption basket is more than 50% food)
- 1.2. Trend: Tightening energy markets
 - 1.2.1. Issue of concern: Vulnerability to supply-side disruption
 - 1.2.1.1. Risk: Oil or gas prices rise steeply due to a major supply disruption (decreased global supply by 10% for several months)
- 1.3. Trend: Macroeconomic Imbalances
 - 1.3.1. Issue of concern: Unsustainability of US current account deficit
 - 1.3.1.1. Risk: An abrupt, major fall in the value of the US dollar with impacts throughout the financial system
- 1.4. Trend: Rise of Chinese Economic Power
 - 1.4.1. Issue of concern: Sustainability of Chinese economic growth
 - 1.4.1.1. Risk: Domestic social/political issues combine to reduce Chinese growth to 6% or less (sustained slower growth)
- 1.5. Trend: Ageing populations in developed economies
 - 1.5.1. Issue of concern: Potential for fiscal crises
 - 1.5.1.1. Risk: Declining fiscal positions force multiple governments of wealthy countries to raise taxes, leading to economic stagnation
- 1.6. Trend: High and increasing asset prices fuelled by unprecedented liquidity
 - 1.6.1. Issue of concern: Asset ‘bubble’ and credit crunch
 - 1.6.1.1. Risk: House and other asset prices collapse in the US, United Kingdom and Europe, significantly reducing consumer spending and creating a recession

2. Geopolitics – 7 trends, 9 issues of concern, 12 risks

2.1. Trend: Rise of non-traditional/asymmetric warfare

2.1.1. Issue of concern: International terrorism

2.1.1.1. Risk: International terrorists mount multiple attacks with conventional and chemical (but not nuclear) weapons, causing significant economic and human losses and exacerbating the retrenchment from globalization

2.2. Trend: Proliferation of Weapons of Mass Destruction

2.2.1. Issue of concern: Potential spread of nuclear capabilities

2.2.1.1. Risk: Collapse of the Non-Proliferation Treaty (NPT) leads to multiple states simultaneously pursuing nuclear technologies and weaponization, with associated increase in geopolitical tensions dragging on the global economy

2.3. Trend: Reconfiguration of global power

2.3.1. Issue of concern: War

2.3.1.1. Risk: US/Iran conflict

2.3.1.2. Risk: US/Democratic People's Republic of Korea conflict

2.4. Trend: Widening gap between “geographies of order and disorder”

2.4.1. Issue of concern: Failed and failing states

2.4.1.1. Risk: US/Iran conflict Nation building in Afghanistan fails, providing haven for international terrorist groups and triggering the decline of the Pakistani state

2.4.1.2. Risk: Disorder in the Horn of Africa worsens as multiple states descend into conflict and offer haven for terrorist groups

2.4.1.3. Risk: A fragile Latin American regime collapses suddenly, spreading political and economic uncertainty throughout the region

2.5. Trend: Global integration outpacing international policing capabilities

2.5.1. Issue of concern: Transnational crime

2.5.1.1. Risk: Penetration of organized crime in the global economy increases significantly over a 10-year period, weakening state authority, worsening the investment climate and slowing growth

2.6. Trend: Retrenchment from globalization

2.6.1. Issue of concern: Rising protectionism in developed economies

2.6.1.1. Risk: Multiple developed economies adopt policies (tariffs, WTO disputes) which retard existing trade and further undermine talks on increased global integration

2.6.2. Issue of concern: Rising economic nationalism in developing economies

2.6.2.1. Risk: Multiple significant emerging economies advance policies that harm foreign direct investment and slow the engine of global growth

2.7. Trend: Intractability of Middle East conflicts

2.7.1. Issue of concern: Israeli/Palestinian conflict

2.7.1.1. Risk: Worsening conflict in the Occupied Territories claims thousands of lives over a 10-year period, and exacerbates geopolitical tensions and economic decline throughout the region

2.7.2. Issue of concern: War in Iraq

2.7.2.1. Risk: All forms of violence in Iraq – sectarian, insurgent, terrorist – worsen and claim thousands of lives. Failure to achieve peace destabilizes the region on an ongoing basis.

3. Environment – 3 trends, 6 issues of concern, 7 risks

3.1. Trend: Climate Change/Global Warming

3.1.1. Issue of concern: Increase in extreme weather events

3.1.1.1. Risk: Extreme weather events linked to climate change will impact businesses and society at large (e.g. multiple tropical cyclones make landfall along the Gulf Coast, India, Bangladesh or China over a 10-year period)

3.1.2. Issue of concern: Changing rainfall patterns

3.1.2.1. Risk: More frequent and severe heatwaves and droughts have harsh impacts on agricultural yields around the world

3.2. Trend: Ecosystem degradation

3.2.1. Issue of concern: Loss of freshwater services

3.2.1.1. Risk: Declining quality and quantity of water in several major watersheds leads to water shortages and increased prevalence of water-borne disease

3.3. Trend: Increasing human exposure to natural catastrophes

3.3.1. Issue of concern: Earthquakes

3.3.1.1. Risk: Natural catastrophe: A strong earthquake hits an economic centre such as Tokyo, Los Angeles or San Francisco

3.3.1.2. Risk: Natural catastrophe: A strong earthquake or seaquake (followed by a strong tsunami) hits a developing country such as China, India or Indonesia

3.3.2. Issue of concern: Inland flooding

3.3.2.1. Risk: Natural catastrophe: Extreme inland flooding of the Mississippi, Yangtze, Thames or Rhine rivers causes direct economic and human losses and serious disruption downstream

3.3.3. Issue of concern: Tropical hurricanes

3.3.3.1. Risk: Natural catastrophe: Category 5 tropical hurricane hits an economic centre such as Tokyo or southern Florida

4. Society – 4 trends, 4 issues of concern, 4 risks

4.1. Trend: Greater interconnectedness of social systems

4.1.1. Issue of concern: Potential for fast-travelling pathogens

4.1.1.1. Risk: A pandemic disease jumps from the animal population to humans, with high mortality and transmission rates following.

4.2. Trend: Increasing prevalence of infectious disease in the developing world

4.2.1. Issue of concern: Potential for worsening of global AIDS/TB/malaria epidemics

4.2.1.1. Risk: Incidence of infectious disease continues to rise in Africa and rises dramatically in Russia and South-East Asia (TB and HIV/AIDS)

4.3. Trend: Increasing burden of chronic disease in the developed world

4.3.1. Issue of concern: Conflation of obesity/diabetes/Cardiovascular disease

4.3.1.1. Risk: Chronic diseases are widespread in the developed world

4.4. Trend: Spread of liability regimes

4.4.1. Issue of concern: Potential spread of US-style liability regimes domestically and internationally

4.4.1.1. Risk: US liability costs increase at four times the rate of GDP growth, and spread rapidly to Europe and Asia. Capacity for global insurance is reduced, undermining investment and growth

5. Technology – 2 trends, 2 issues of concern, 2 risks

5.1. Trend: Increasingly interdependent critical information infrastructure (CII)

5.1.1. Issue of concern: Vulnerability of CII to attack or system failure

5.1.1.1. Risk: Attack or system failure in CII creates a domino effect, shutting down IT-dependent applications in power, water, transport, banking and finance, and emergency management

5.2. Trend: Development of technology on the nanoscale

5.2.1. Issue of concern: Potential toxicity of nanoparticles

5.2.1.1. Risk: Studies reveal health impairment due to exposure to widely used nanoparticles (paint, cosmetics, healthcare). Primary impacts on public health and secondary impacts on investment in a range of nanotechnologies

Appendix 2: Risk Assessments

The risk assessments below provide the best aggregate view of the partners involved in this report. All assessments have resulted from group discussion, but they contain varying degrees of certainty and agreement as to the manifestation of the risk both in terms of likelihood and severity. Certain risks can be assessed for likelihood using traditional actuarial models – particularly natural catastrophe risks. For other risks – particularly geopolitical risks – the ranges of possible outcomes are much wider and correspondingly uncertainty looms large.

The assessments below are not a fixed view of how the world will turn out over a 10-year time frame. Many of the risks are open to mitigation measures

which will alter likelihood and severity within 10 years; for others likelihood and severity may change due to inaction or shifts in underlying causal trends and, in all cases, new information may alter our future perspective on likelihood and mitigation.

Most risk definitions are broadly similar from 2007 to 2008, but a number of other definitions have been sharpened to increase granularity of measurement, and geopolitical risks have been disaggregated for the purposes of assessment. The 2007 and 2008 assessments are therefore broadly, but not directly, comparable.

Risk Assessments – Economic Loss

	LIKELIHOOD	SEVERITY (US\$)
1	below 1%	2-10 billion
2	1-5%	10-50 billion
3	5-10%	50-250 billion
4	10-20%	250 billion-1 trillion
5	above 20%	>1 trillion

	2008		2007	
	LIKELIHOOD	SEVERITY	LIKELIHOOD	SEVERITY
ECONOMICS			ECONOMICS	
Rising and volatile prices create significant shortages for poor people globally (those whose consumption basket is more than 50% food)	3	3		
Oil or gas prices rise steeply due to a major supply disruption (decreased global supply of 10% for several months)	4	4	Oil price shock	4
An abrupt, major fall in the value of the US dollar over time with impacts throughout the financial system	3.5	3	US current account deficit	3
Domestic social/political issues combine to slow Chinese growth to 6% or less (sustained over time)	3.5	4	China hard landing	4
Declining fiscal positions force multiple governments of wealthy countries to raise taxes, leading to economic stagnation	2	3	Coming fiscal crises caused by demographic shift	2
House and other asset prices collapse in the US, United Kingdom and continental Europe, reducing consumer spending and creating a recession	4.5	5	Blow up in asset prices/indebtedness	4

	2008		2007	
	LIKELIHOOD	SEVERITY	LIKELIHOOD	SEVERITY
GEOPOLITICS	GEOPOLITICS			
International terrorists mount multiple attacks with conventional and chemical (but not nuclear) weapons, causing significant economic and human losses and exacerbating the retrenchment from globalization	3	2	International terrorism	4
Collapse of NPT leads to multiple states simultaneously pursuing nuclear technologies and weaponization, with associated increase in geopolitical tensions dragging on the global economy	3.5	1.5	Proliferation of WMD	3.5
Interstate & civil wars • US/Iran conflict • US/Democratic People's Republic of Korea conflict	3 3 2.5	3 3 3		
Failed & failing states • Nation building in Afghanistan fails, providing haven for international terrorist groups and triggering the decline of the Pakistani state • Disorder in the Horn of Africa worsens as multiple states descend into conflict and offer haven for terrorist groups • A fragile Latin American regime collapses suddenly, spreading political and economic uncertainty throughout the region	4 4.5 4 2	2.5 2 1 2	Failed and failing states Interstate and civil wars	4 3.5 4
Penetration of organized crime in the global economy increases significantly over a 10-year period, weakening state authority, worsening the investment climate and slowing growth	3	3	Transnational crime and corruption	3.5
Multiple developed economies take steps (tariffs, WTO disputes) which retard existing trade and further undermine talks on increased global integration	3	5		
Multiple significant emerging economies advance policies that harm foreign direct investment and slow the engine of global growth	3.5	3	Retrenchment from globalization	2.5

		2008		2007	
		LIKELIHOOD	SEVERITY	LIKELIHOOD	SEVERITY
GEOPOLITICS		GEOPOLITICS			
Middle-East instability		4 3	3.5 2.5	Middle East instability	4.5 3.5
• Worsening conflict in the Occupied Territories claims thousands of lives over a 10-year period, and exacerbates geopolitical tensions and economic decline throughout the region		5	2.5		
• All forms of violence in Iraq – sectarian, insurgent, terrorist – worsen and claim thousands of lives. Failure to achieve peace destabilizes the region on an ongoing basis					
ENVIRONMENT		ENVIRONMENT			
Extreme weather events linked to climate change will impact businesses and society at large (e.g. multiple tropical cyclones make landfall along the Gulf Coast, India, Bangladesh or China over a 10-year period)	3.5	3	Climate change	3	3
More frequent and severe heatwaves and droughts have harsh impacts on agricultural yields around the world	3.5	3			
Declining quality and quantity of water in several major watersheds leads to water shortages and increased prevalence of water-borne disease.	3	2	Loss of freshwater	3.5	2.5
Natural catastrophe: Category 5 tropical cyclone hits an economic centre such as Tokyo or southern Florida	2	3	Natural catastrophe: Tropical Storms	2	3
Natural catastrophe: A strong earthquake hits an economic centre such as Tokyo, Los Angeles or San Francisco	2	3	Natural catastrophe: Earthquakes	2	3
Natural catastrophe: Extreme inland flooding of the Mississippi, Yangtze, Thames or Rhine rivers causes direct economic and human losses and serious disruption downstream	2	2.5	Natural catastrophe: Inland Flooding	2	2.5

		2008		2007	
		LIKELIHOOD	SEVERITY	LIKELIHOOD	SEVERITY
SOCIETY		SOCIETY			
A pandemic disease jumps from the animal population to humans, with high mortality and transmission rates following	3	4	Pandemics	2	4
Incidence of infectious disease continues to rise in Africa and rises dramatically in Russia and South-East Asia (TB and HIV/AIDS)	2.5	3	Infectious disease in the developing world	3	2.5
Chronic diseases become widespread in the developed world	4	3.5	Chronic disease in developed countries	4.5	3
US liability costs increase at 4x the rate of GDP growth, and spread rapidly to Europe and Asia. Capacity for global insurance is reduced, undermining investment and growth	3	3	Liability regimes	3	3
TECHNOLOGY		TECHNOLOGY			
Attack or system failure in CII creates a domino effect, shutting down IT-dependent applications in power, water, transport, banking and finance, and emergency management	3.5	3.5	Breakdown of critical information infrastructure (CII)	3	3.5
Studies reveal health impairment due to exposure to widely used nanoparticles (paint, cosmetics, healthcare). Primary impacts on public health and secondary impacts on investment in a range of nanotechnologies	2	2-2.5	Emergence of risks associated with nanotechnology	2	2

Risk assessments – Lives lost

	LIKELIHOOD	SEVERITY (deaths)
1	below 1%	1 600-8 000
2	1-5%	8 000-40 000
3	5-10%	40 000-200 000
4	10-20%	200 000-1million
5	above 20%	>1million

		2008		2007	
		LIKELIHOOD	SEVERITY	LIKELIHOOD	SEVERITY
ECONOMICS		ECONOMICS			
Rising and volatile prices create significant shortages for poor people globally (those whose consumption basket is more than 50% food)		3	5		
GEOPOLITICS		GEOPOLITICS			
International terrorists mount multiple attacks with conventional and chemical (but not nuclear) weapons, causing significant economic and human losses and exacerbating the retrenchment from globalization	3	2	International terrorism	4	1.5
Collapse of NPT leads to multiple states simultaneously pursuing nuclear technologies and weaponization, with associated increase in geopolitical tensions dragging on the global economy	3.5	2	Proliferation of WMD	3.5	0.5
Interstate & civil wars <ul style="list-style-type: none"> • US/Iran conflict • US/Democratic People's Republic of Korea conflict 	3.5 3 2.5	4 3 3	US/China conflict	3.5	4
Failed & failing states <ul style="list-style-type: none"> • Nation building in Afghanistan fails, providing haven for international terrorist groups and triggering the decline of the Pakistani state • Disorder in the Horn of Africa worsens as multiple states descend into conflict and offer haven for terrorist groups • A fragile Latin American regime collapses suddenly, spreading political and economic uncertainty throughout the region 	4 4.5 4 2	3.5 2 2 1	Failed and failing states	4	3.5
Penetration of organized crime in the global economy increases significantly over a 10-year period, weakening state authority, worsening the investment climate and slowing growth	3	1	Interstate and civil wars	3.5	4
			Transnational crime and corruption	3.5	2

	2008		2007	
	LIKELIHOOD	SEVERITY	LIKELIHOOD	SEVERITY
GEOPOLITICS			GEOPOLITICS	
Middle-East instability	4 3	3 2	Middle East instability	4.5 3
<ul style="list-style-type: none"> Worsening conflict in the Occupied Territories claims thousands of lives over a 10-year period, and exacerbates geopolitical tensions and economic decline throughout the region All forms of violence in Iraq – sectarian, insurgent, terrorist – worsen and claim thousands of lives. Failure to achieve peace destabilizes the region on an ongoing basis 				
ENVIRONMENT			ENVIRONMENT	
Extreme weather events linked to climate change will impact businesses and society at large (e.g. multiple tropical cyclones make landfall along the Gulf Coast, India, Bangladesh or China over a 10-year period)	3.5	2.5		
More frequent and severe heatwaves and droughts have harsh impacts on agricultural yields around the world	3.5	2		
Declining quality and quantity of water in several major watersheds leads to water shortages and increased prevalence of water-borne disease	3	2.5	Loss of freshwater	3.5 3
Natural catastrophe: Category 5 tropical cyclone hits a densely populated area in an emerging country such as India, China or Bangladesh.	4	3	Natural catastrophe: Tropical Storms	Not available
Natural catastrophe: A strong earthquake or seaquake (followed by a strong tsunami) hits a developing country such as China, India or Indonesia	2	4	Natural catastrophe: Earthquakes	Not available
Natural catastrophe: Extreme inland flooding of the Mississippi, Yangtze, Thames or Rhine rivers causes direct economic and human losses and serious disruption downstream	2	2.5	Natural catastrophe: Inland Flooding	2 2

	2008		2007	
	LIKELIHOOD	SEVERITY	LIKELIHOOD	SEVERITY
SOCIETY		SOCIETY		
A pandemic disease jumps from the animal population to humans, with high mortality and transmission rates following	3	5	Pandemics	2 4
Incidence of infectious disease continues to rise in Africa and rises dramatically in Russia and South-East Asia (TB and HIV/AIDS)	2.5	5	Infectious disease in the developing world	3 5
Chronic diseases become widespread in the developed world	4	4	Chronic disease in developed countries	4 4
TECHNOLOGY		TECHNOLOGY		
Attack or system failure in CII creates a domino effect, shutting down IT-dependent applications in power, water, transport, banking and finance, and emergency management	3.5	1	Breakdown of critical information infrastructure (CII)	3 1
Studies reveal health impairment due to exposure to widely used nanoparticles (paint, cosmetics, healthcare). Primary impacts on public health and secondary impacts on investment in a range of nanotechnologies	2	1	Emergence of risks associated with nanotechnology	2 1

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This report was prepared by the Global Risk Team of the World Economic Forum, in conjunction with, and with inputs from, its partners.

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Over the past year the Global Risk Network has engaged with a wider group of experts in workshops held at The Wharton School in May, in London and Zurich in July, and in New York in October. These workshops, along with the risk assessment process and risk-related sessions in the broader context of World Economic Forum events in Singapore, Dalian and elsewhere, have provided broad expertise and invaluable insight for the writing of the current report. They are an integral part of the Global Risk Network's mandate to originate and support multistakeholder dialogues to improve understanding of global risk and to increase the possibilities for risk mitigation.

We would like to thank participants for their time – and above all for their insights:

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