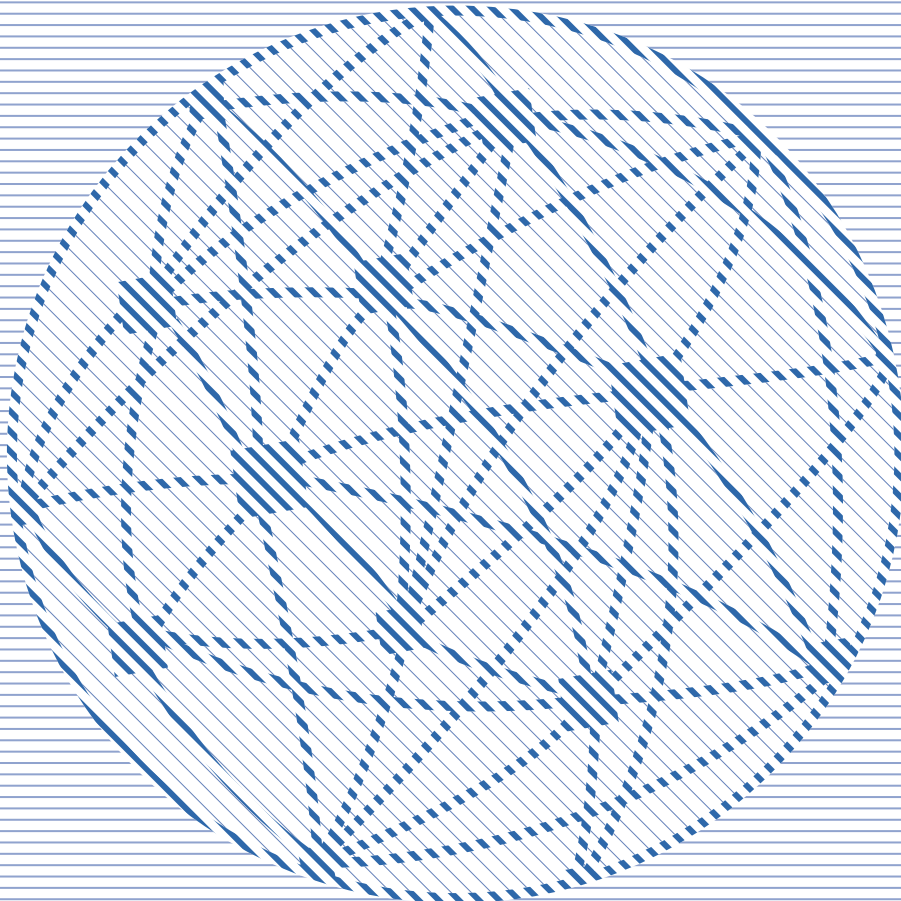


Insight Report

Global Risks 2012

Seventh Edition

An Initiative of the Risk Response Network



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Global Risks 2012

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World Economic Forum in collaboration with:

Marsh & McLennan Companies

Swiss Reinsurance Company

Wharton Center for Risk Management,
University of Pennsylvania

Zurich Financial Services

Figure 1: Five Global Risk Categories – Landscapes

Landscapes depict potential impact and likelihood of global risks over the next 10 years, as rated on a 1 to 5 scale by respondents of the Global Risks Survey.



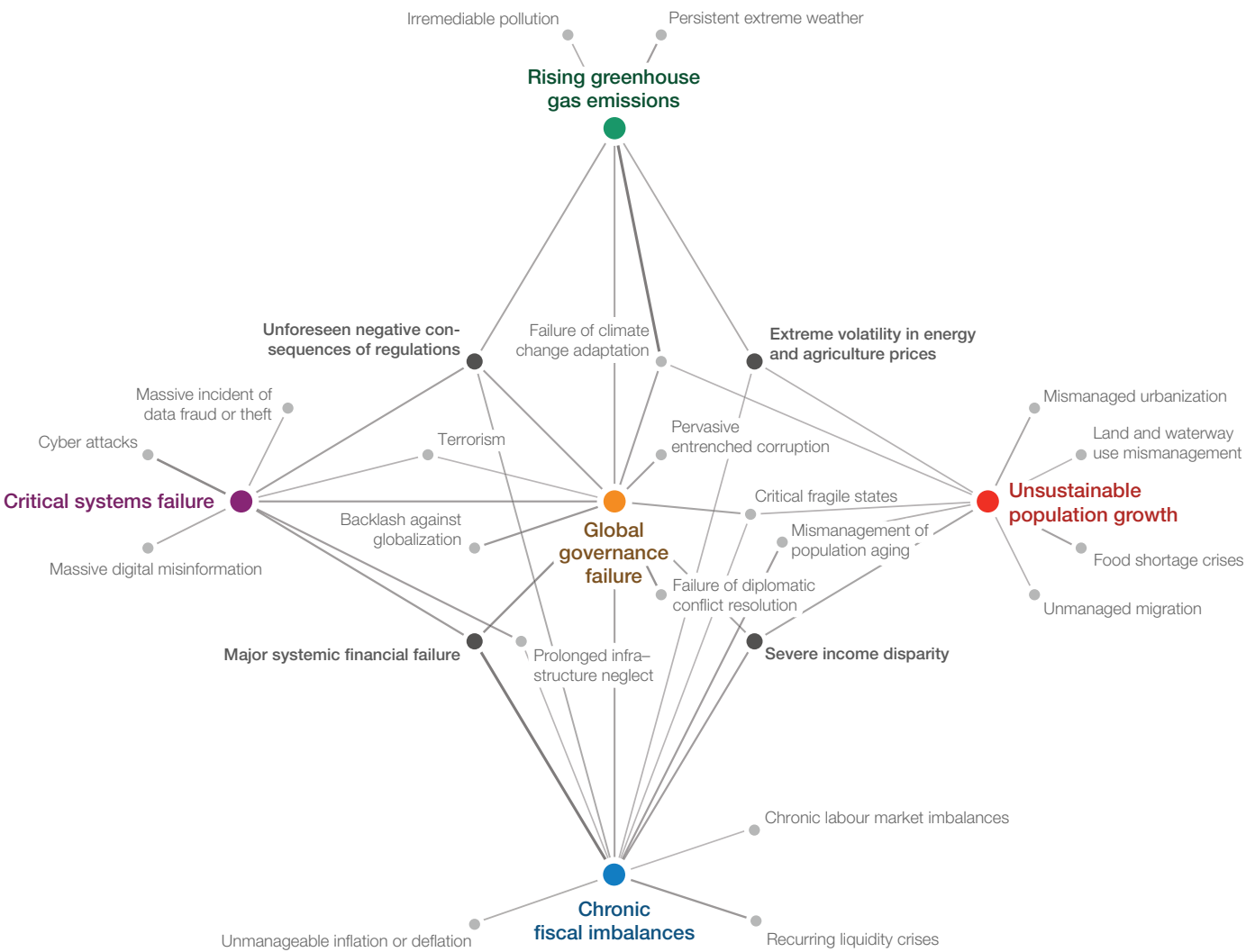
Source: World Economic Forum

Figure 2: Global Risks Landscape 2012



Source: World Economic Forum

Figure 3: Global Risks Map 2012



Source: World Economic Forum

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Preface



The more complex the system, the greater the risk of systemic breakdown, but also the greater the potential for opportunity. Together, we have the foresight and collaborative spirit to shape our global future and particularly the survival instinct to move from pure urgency-driven risk management to more collaborative efforts aimed at strengthening risk resilience to the benefit of global society.

Klaus Schwab
Founder and Executive Chairman
World Economic Forum

Across every sector of society, decision-makers are struggling with the complexity and velocity of change in an increasingly interdependent world. The context for decision-making has evolved, and in many cases has been altered in revolutionary ways. In the decade ahead, our lives will be more intensely shaped by transformative forces, including economic, environmental, geopolitical, societal and technological seismic shifts. The signals are already apparent with the rebalancing of the global economy, the presence of over seven billion people and the societal and environmental challenges linked to both. The resulting complexity threatens to overwhelm countries, companies, cultures and communities.

We need to explore and develop new conceptual models which address global challenges. It is in this spirit that I present the World Economic Forum's *Global Risks 2012* report. Now in its seventh edition, the report features more refined risk descriptions and rigorous data analysis covering 50 global risks. It aims to improve public and private sector efforts to map, monitor, manage and mitigate global risks. It is also a "call to action" for the international community to improve current efforts at coordination and collaboration, as none of the global risks highlighted respects national boundaries.

This report captures the input of risk leaders in thought and practice, including members of the World Economic Forum's Global Agenda Councils. It is also underpinned by the support and guidance of all the partners of the Risk Response Network. Underlying all these risks are velocity, multiplicity, and interconnectivity – creating a global system where mastering complexities will be the foremost challenge.

Foreword



The World Economic Forum's Risk Response Network (RRN) was launched to provide private and public sector leaders with an independent, impartial platform to map, measure, monitor, manage and mitigate global risks. Our flagship research activity is this report.

Now in its seventh edition, the report's research methodology has been significantly revamped. Data and analysis are based on a newly designed survey covering a meaningfully expanded set of 50 global risks across five categories. The assessments of these risks more than doubled as a result of this year's survey, with 469 experts and industry leaders responding worldwide. The survey captures the perceived impact and likelihood for each risk over a 10-year time horizon using a clear and simple five-point scale to indicate the severity of impact, which provides a more intuitive measure than the billions of US dollars or hundreds of thousands of lives used in previous years. All of the above was achieved as a result of the unprecedented support from the Forum's Network of Global Agenda Councils of over 1,000 renowned experts worldwide.

Readers will also see marked improvements in data analysis and visualization in this report. A dynamic assessment of each global risk will be available via a new digital platform, "*Toplink*." It is a collaborative, intelligence-sharing platform with a social media interface and mobile applications for those engaged in the RRN. The "risk radar" and dynamic "risk barometer" are among the innovative analytical and measurement tools currently in development. Many of these features are also available on the Forum's website.

An important aim of *Global Risks 2012* is to help decision-makers evaluate complex risk events and to respond proactively in times of crisis – hence the inclusion this year of a special report on the 11 March crisis in Japan. Moreover, each of the three cases in this report now feature key discussion questions to contemplate in this regard. The RRN will also focus on the three cases by convening board members, risk executives and policy-makers at the highest level at Forum events throughout the year ahead, to discuss resilient global risk management.

Looking beyond 2012, the Risk Response Network will explore the global risks highlighted in this report in their appropriate regional, country or industry contexts by launching task forces and initiatives designed specifically for their mitigation. Many of these efforts will be driven by an interdisciplinary and multistakeholder community, the Network of Global Agenda Councils, as they are the key experts focusing on risk mitigation within the RRN.

We look forward to your comments and feedback, as our aim is to enhance the quality and impact of this report each and every year as part of the Forum's commitment to improve the state of the world.

A handwritten signature in black ink, appearing to read 'Lee Howell'.

Lee Howell
Managing Director
Risk Response Network

Executive Summary

The World Economic Forum's *Global Risks 2012* report is based on a survey of 469 experts from industry, government, academia and civil society that examines 50 global risks across five categories.

The report emphasizes the singular effect of a particular constellation of global risks rather than focusing on a single existential risk. Three distinct constellations of risks that present a very serious threat to our future prosperity and security emerged from a review of this year's set of risks.

The three risk cases describe the links across a selection of the global risks, their interplay and how they are likely to develop over the next 10 years. The cases are initially based on a quantitative analysis of interconnections identified in the survey and then developed further via a qualitative analysis conducted through Forum workshops worldwide and follow-up discussions with project advisors.

Case 1: Seeds of Dystopia

Dystopia, the opposite of a utopia, describes a place where life is full of hardship and devoid of hope. Analysis of linkages across various global risks reveals a constellation of fiscal, demographic and societal risks signalling a dystopian future for much of humanity. The interplay among these risks could result in a world where a large youth population contends with chronic, high levels of unemployment, while concurrently, the largest population of retirees in history becomes dependent upon already heavily indebted governments. Both young and old could face an income gap, as well as a skills gap so wide as to threaten social and political stability.

This case underscores the danger that could arise if declining economic conditions jeopardize the social contracts between states and citizens. In the absence of viable alternatives, this could precipitate a downward spiral of the global economy fuelled by protectionism, nationalism and populism.

Case 2: How Safe are our Safeguards?

As the world grows increasingly complex and interdependent, the capacity to manage the systems that underpin our prosperity and safety is diminishing. The constellation of risks arising from emerging technologies, financial interdependence, resource depletion and climate change exposes the weak and brittle nature of existing safeguards – the policies, norms, regulations or institutions which serve as a protective system. Our safeguards may no longer be fit to manage vital resources and ensure orderly markets and public safety.

The interdependence and complexity inherent in globalization require engaging a wider group of stakeholders to establish more adaptable safeguards which could improve effective and timely responses to emerging risks.

Case 3: The Dark Side of Connectivity

The impacts of crime, terrorism and war in the virtual world have yet to equal that of the physical world, but there is fear that this could change. Hyperconnectivity is a reality. With over five billion mobile phones coupled with internet connectivity and cloud-based applications, daily life is more vulnerable to cyber threats and digital disruptions. The related constellation of global risks in this case highlights that incentives are misaligned with respect to managing this global challenge. Online security is now considered a public good, implying an urgent need to encourage greater private sector engagement to reduce the vulnerability of key information technology systems.

While significant material and human resources were required in the past to exercise political or economic influence on a global scale, borders have become permeable as power shifts from the physical to the virtual world. A healthy digital space is needed to ensure stability in the world economy and balance of power.

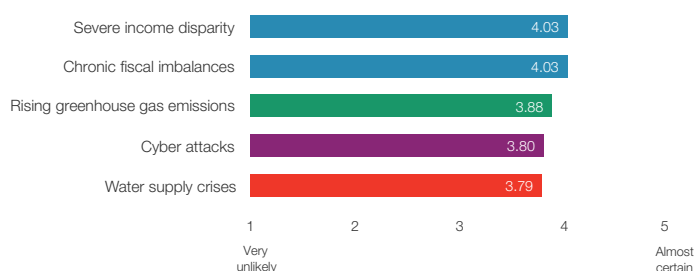
Special Report: The Great East Japan Earthquake

This section of the report features a special review of the important lessons learned from the 2011 earthquake, tsunami and the subsequent nuclear crisis at Fukushima, Japan. It focuses on the role of leadership, challenges to effective communication in this information age and resilient business models in response to crises of unforeseen magnitude.

50 Global Risks

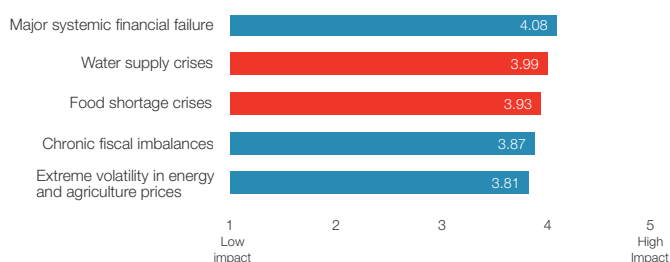
Structured on a 10-year outlook, the survey captured the perceived impact, likelihood and interconnectedness of 50 prevalent global risks. Figures 4 and 5 respectively show the average ratings of the five risks which were assessed in this year's survey as having the highest perceived likelihood and potential impact over the next 10 years (see Appendix 2 for a full breakdown of survey responses).

Figure 4: Top 5 in terms of Likelihood



Source: World Economic Forum

Figure 5: Top 5 in terms of Impact



Source: World Economic Forum

As explained in the section on methodology, the 2012 report introduces the concept of Centres of Gravity – those risks perceived by survey respondents to be of greatest systemic importance within each of the five risk categories. For risk-related planning, Centres of Gravity should serve as focal points to guide strategic interventions. The 2012 Centres of Gravity are:

- Chronic fiscal imbalances (economic)
- Greenhouse gas emissions (environmental)
- Global governance failure (geopolitical)
- Unsustainable population growth (societal)
- Critical systems failure (technological)

The report also looks ahead to X Factors, which require further research. The notion of a volcanic winter, epigenetics and mega-accidents are some X factors for future consideration.

This report serves as the research base on which the Risk Response Network works together on mapping, monitoring, managing and mitigating global risks.

Glossary

Five Risk Categories in the report: economic, environmental, geopolitical, societal and technological.

Centres of Gravity are the risks of greatest systemic importance, as identified by the Global Risks Survey.

Critical Connectors are risks connected to multiple Centres of Gravity, and join the five centres of gravity into one coherent system.

In this report **global risks** are defined as having global geographic scope, cross-industry relevance, uncertainty as to how and when they will occur, and high levels of economic and/or social impact requiring a multistakeholder response.

Weak Signals exhibit the weakest links to other risks and high uncertainty in terms of variation in survey ratings of impact and likelihood.

X Factors are emerging concerns of possible future importance and with unknown consequences. Although they are not considered among the global risks surveyed, they were submitted by experts as issues to monitor in the future.

Box 1: The Evolving Risk Landscape

The risk landscape in this 2012 report is based on a refined and expanded set of 50 risks, compared to 37 in previous years. This means that comparisons to the 2011 report are not one-to-one. However, it is clear that respondents' concern has shifted from environmental risks in 2011 to socioeconomic risks in 2012, as shown in Box 1. Economic risks have displaced environmental risks as those considered most likely. In 2011, the risks perceived as having the highest potential impact were economic and environmental; in 2012, they are economic and societal.



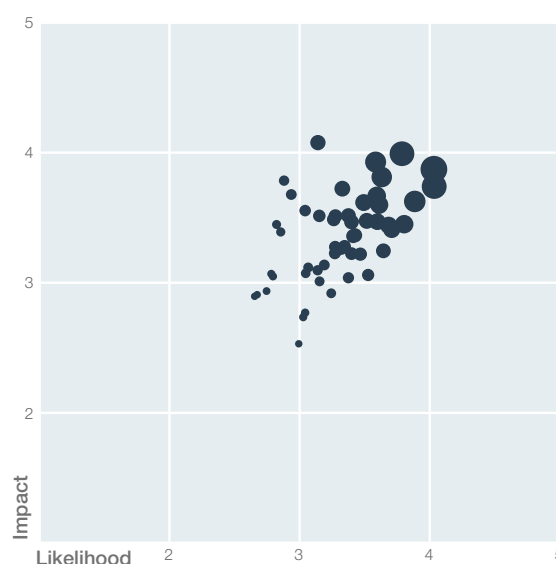
Source: World Economic Forum

Methodology and Survey Results

The seventh edition of the *Global Risks* report is based on a revamped methodology combining surveys, workshops and interviews that engage various stakeholders of the World Economic Forum. The starting point is a set of 50 global risks – which are defined as having global geographic scope, cross-industry relevance, uncertainty as to how and when they may occur, and high levels of economic and/or social impact requiring a multistakeholder approach to response. They are divided into five categories: economic, environmental, geopolitical, societal and technological risks. The 2012 list was revised through workshops and interviews with leading experts from the World Economic Forum’s multistakeholder communities.

The list was then assessed by a larger group of experts taking part in the Global Risks Survey – 469 respondents gauged the likelihood and potential impact of each of these risks over the next decade. As shown in Figure 6, the majority of risks received an average score located towards the high-impact and high-likelihood ends on the 1-5 scales, which validates the high concern about the 50 risks identified.

Figure 6: All 50 Risks Fall Near the High-Impact/ High-Likelihood End of the Scale



Source: World Economic Forum

The survey respondents were also asked to identify five Centres of Gravity – one per category – as the risks of greatest systemic importance, or the most influential and consequential in relation to others, as well as the risks that are most strongly connected to them. The Global Risks Map 2012 in Figure 7 shows the entire network of these interconnections between global risks.

From the Survey results, the most frequently chosen Centres of Gravity are:

- Chronic fiscal imbalances (economic)
- Greenhouse gas emissions (environmental)
- Global governance failure (geopolitical)
- Unsustainable population growth (societal)
- Critical systems failure (technological)

The strongest connections to the five Centres of Gravity are highlighted as the dark grey, star-shaped constellation to emphasize their impact.

Figure 7: Global Risks Map 2012 (detailed)



Source: World Economic Forum

Analysis of the 2012 Global Risks Map reveals four risks as playing significant roles in connecting the Centres of Gravity to each other. These four Critical Connectors, which link the main clusters of the system, are highlighted as black dots in the diagram. They are:

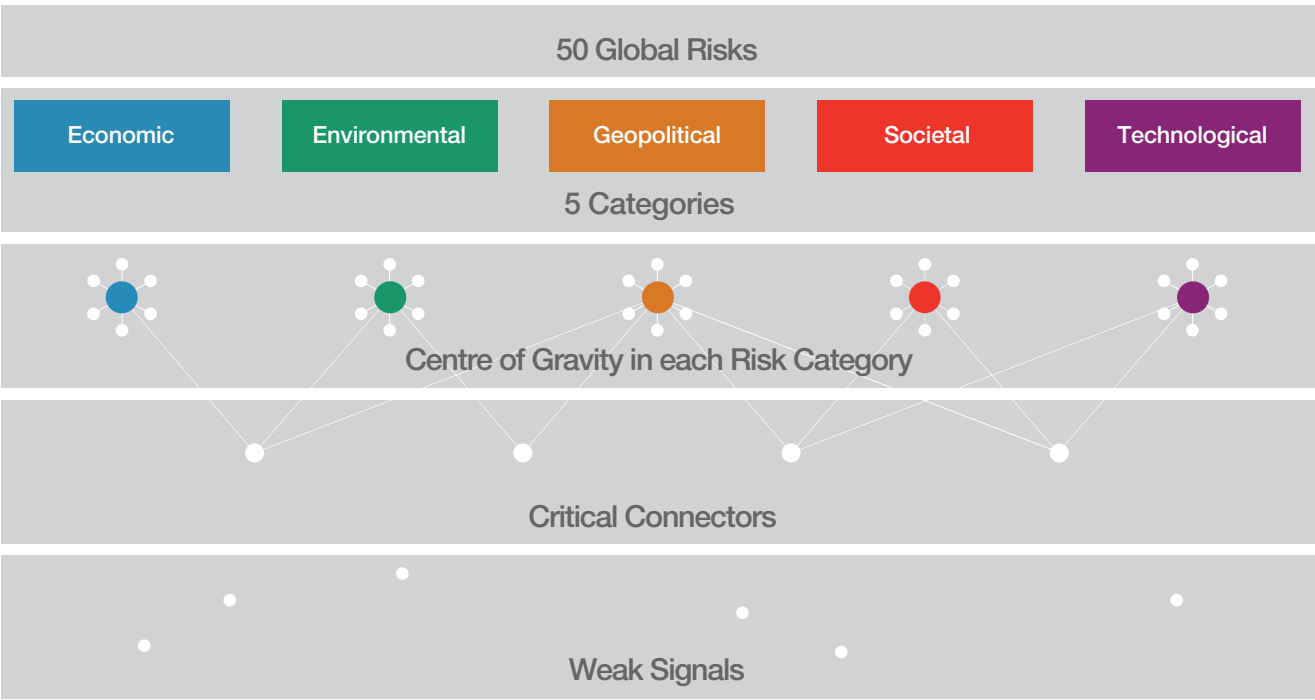
- Severe income disparity (economic)
- Major systemic financial failure (economic)
- Unforeseen negative consequences of regulation (economic)
- Extreme volatility in energy and agriculture prices (economic)

Weak Signals are defined as risks which are most loosely connected in the network, based on how many links they have and how often these were selected by survey respondents. The top five Weak Signals are:

- Vulnerability to geomagnetic storms (environmental)
- Proliferation of orbital debris (technological)
- Unintended consequences of nanotechnology (technological)
- Ineffective drug policies (societal)
- Militarization of space (geopolitical)

They have almost without exception received relatively low-impact and low-likelihood scores, and in most cases exhibit a significant variation in how survey respondents perceive them, particularly among the different regions. Weak Signals will not be addressed explicitly in the cases considered in this report, though it is worth bearing in mind that some experts did rate their connectedness and severity more highly.

Figure 8: Typology of Global Risks



Source: World Economic Forum

The typology of global risks, as summarized in Figure 8, enables a more structured approach to the complexity of interconnections than has been possible in previous reports.

The 2012 survey also revealed variations in the risk perceptions of different groupings of survey respondents. Self-identified experts in a category tended to perceive the likelihood and impact of a risk in their area of expertise as higher than the rest of the survey sample. One exception to this trend was the case of technological risks, where experts often had a lower mean likelihood and impact score when compared to other respondents. Appendix 2 identifies three cases of significant differences in risk perception: first, between the six regions (Asia, Europe, Latin America, Middle East/North Africa, North America and Sub-Saharan Africa); second, between the results of different occupational affiliations (academia, business, government, international organizations, NGOs and others); and third, between self-identified subject area experts versus non-experts.

The subsequent three cases help to explain some of the potential causal relations that the survey data alone cannot substantiate and to underscore the complexity of interconnected global risks that our world faces in the next 10 years.

For more details on the five categories, Centres of Gravity and the list of global risks, refer to Section 4, page 36.

For the full risk landscape, refer to Figure 2, page 5.

Case 1:

Seeds of Dystopia

The word “dystopia” describes what happens when attempts to build a better world unintentionally go wrong. This case considers how current fiscal and demographic trends could reverse the gains brought by globalization and prompt the emergence of a new class of **critical fragile states** – formerly wealthy countries that descend into lawlessness and unrest as they become unable to meet their social and fiscal obligations. Such states could be developed economies where citizens lament the loss of social entitlements, emerging economies that fail to provide opportunities for their young population or to redress rising inequalities, or least-developed economies where wealth and social gains are declining. This case shows that a society that continues to sow the seeds of dystopia – by failing to manage ageing populations, youth unemployment, rising inequalities and fiscal imbalances – can expect greater social unrest and instability in the years to come.

Risk Constellations and Potential Impacts

Two dominant issues of concern emerged from the Arab Spring, the “Occupy” movements worldwide and recent similar incidents of civil discontent: the growing frustration among citizens with the political and economic establishment, and the rapid public mobilization enabled by greater technological connectivity. A macro and longer-term interpretation of these events highlights the need to improve the management of global economic and demographic transformations that stand to increasingly define global social trends in the decade to come.

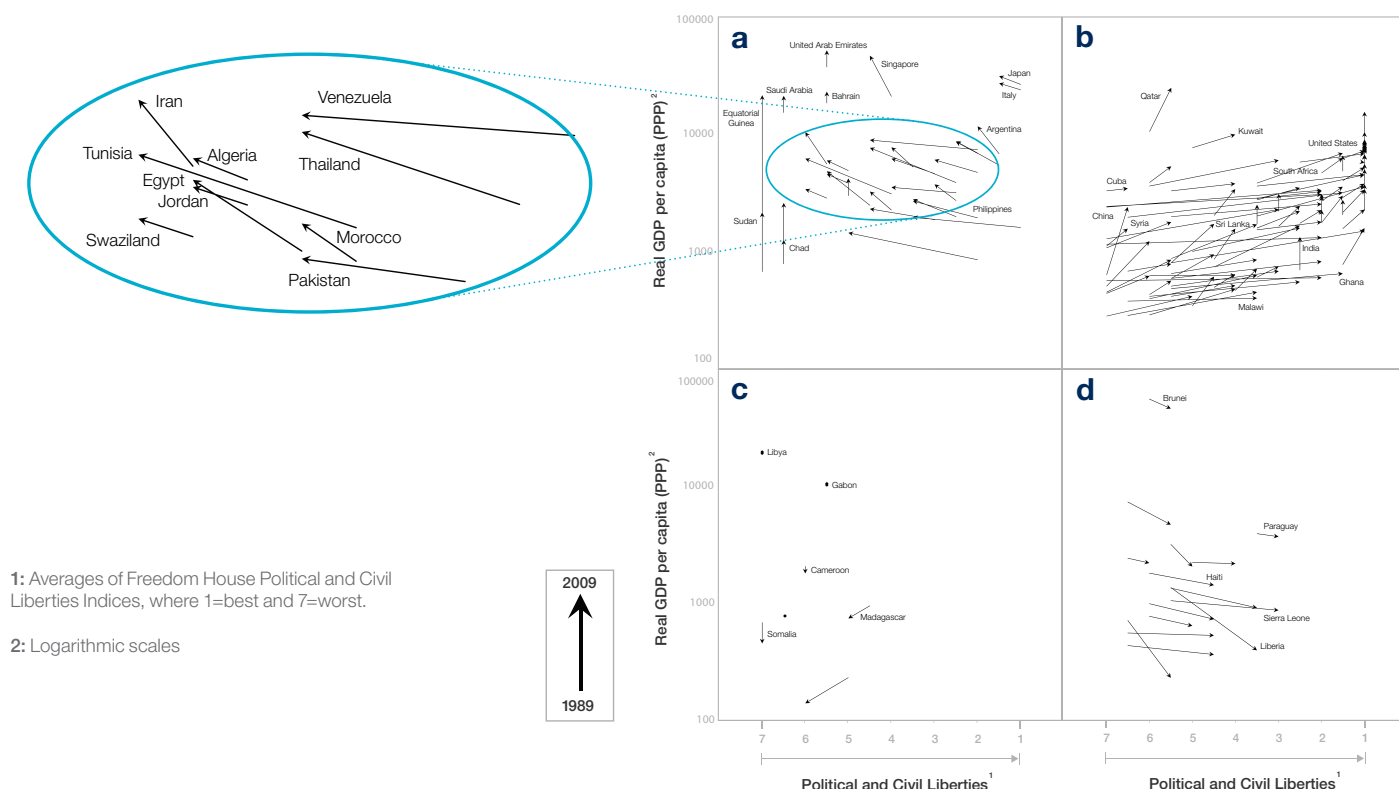
These trends are evolving differently across developed, emerging and least developed economies. In developed economies, such as those of Western Europe, North America and Japan, the social contract that has in recent decades been taken for granted is in danger of being destroyed. Workers nearing retirement fear cutbacks in social entitlements they have grown up to expect, such as state pensions, pre-established retirement age and guaranteed access to quality healthcare.

Meanwhile, young adults in this same group of economies realize that they are part of a compressed labour force that is expected to support a growing population of elderly citizens, while bearing the brunt of austerity measures required to offset growing national debts. At the same time, these same youths must save enough to provide for their own old-age needs in the most challenging economic climate in a generation. Experts anticipate that high unemployment rates will increasingly co-exist with employers’ unmet demands for skilled labour – a sign that many young people may lack the skills needed to make the necessary economic and social contributions.

In emerging economies, the context – and the challenge – is different. Countries such as Indonesia, Vietnam, the Philippines, Mexico, Peru and the BRIC countries (Brazil, Russia, India and China), are racing to take advantage of a demographic window of opportunity presented by large labour forces with relatively few dependents, before this population also ages. These nations’ ability to seize the opportunity is far from guaranteed, given sluggish global growth and reduced demand from developed economies. Rapid economic growth in emerging economies has fuelled an impatient expectation that a rising tide will lift all boats, but social contracts may not be forged quickly enough to rectify increasingly visible economic inequalities and social inequities.

Figure 9: Economic and Socio-political Change

Countries whose citizens have experienced improvement in economic well-being but whose socio-political freedoms have been curtailed:



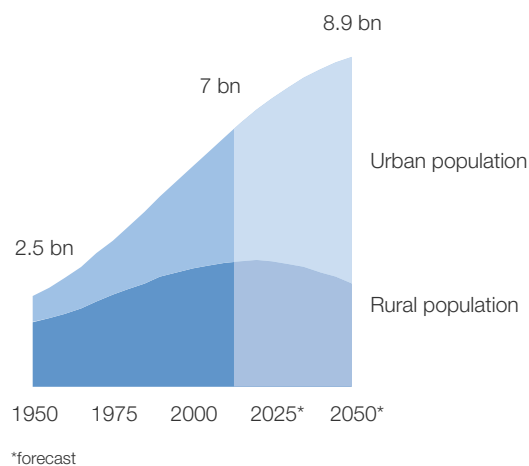
Source: World Economic Forum analysis based on data from Freedom House, Freedom in the World: 2011 Survey Release (2011); and Heston, A., Summers, R. and Aten, B. Penn World Table, Version 7.0 (May 2011)

Failure to meet demands for civil and political rights could also have harmful consequences. Figure 9 shows that in most countries, improvements in economic living standards have been accompanied by increases in political and civil rights such as freedom of speech, assembly and belief. In approximately a dozen countries, citizens who have enjoyed rapid economic growth in the last 20 years have instead seen deterioration in their political and civil freedoms, often resulting in social unrest. A closer look reveals that many countries in this group share recent episodes of social unrest as a common characteristic.

In the world's poorest countries, rapidly increasing populations of young people, who are growing up in extremely vulnerable circumstances, are posing urgent demographic challenges. Least-developed economies and fragile states, such as Afghanistan, Pakistan, Timor-Leste and many Sub-Saharan African countries, are still struggling to ensure basic health and education for their growing populations and to take advantage of the wealth-generating potential of women.

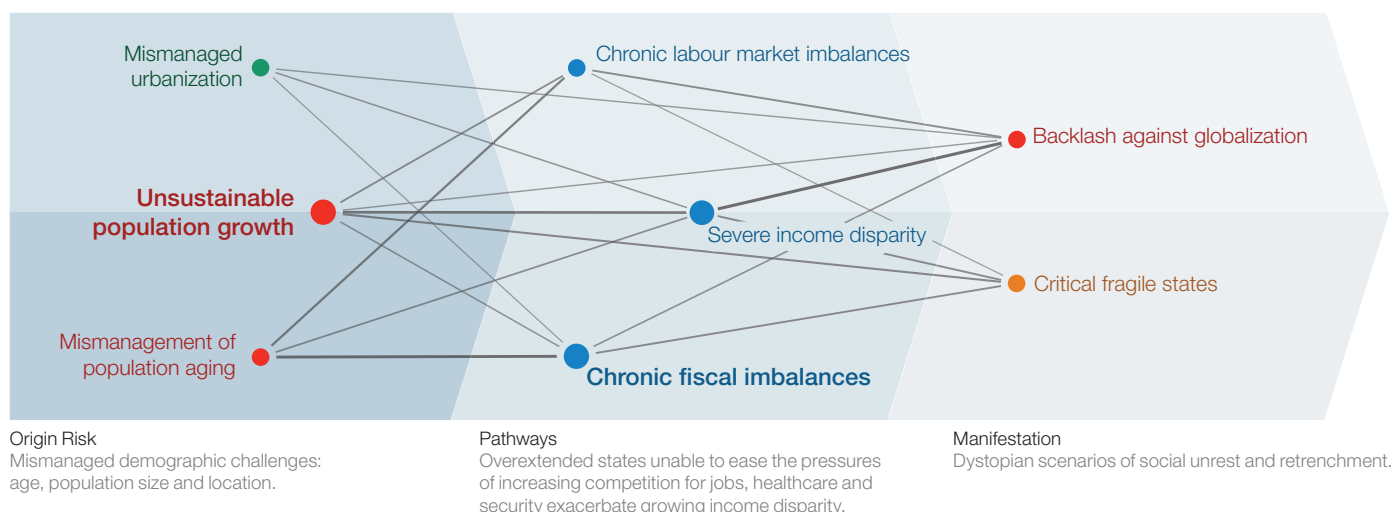
The three distinct economic and demographic contexts described above are linked by migration. Across the globe, as population growth puts pressure on rural economies, people are being rapidly pulled into cities that struggle to absorb the new arrivals in an orderly way. Figure 10 shows that the rural population is expected to decline around 2023, while the urban population will continue to increase. Young people entering the urban labour force often find that their education has not equipped them with the technological skills and entrepreneurial know-how to access employment opportunities presented by global connectivity.

Figure 10: A More Populated and Urban World



Source: World Urbanization Prospects: The 2009 Revision Population Database. United Nations Population Division (2010)

Figure 11: Seeds of Dystopia Constellation



Source: World Economic Forum

Cross-border migration adds a dynamic element to this demographic picture. If managed well, labour can be mobilized from one part of the world to another through legitimate channels that match available skills to employer demands, while also protecting the rights of migrants and their families. In the absence of such channels, higher rates of irregular migration are likely, as is abuse by illicit migration networks and smugglers. Cross-border migration can therefore either be a remedy or a further complication. In addition to irregular migration, experts express greater concern about people who are unable to relocate satisfactorily, grow frustrated and drop out of the formal labour market where they reside.

This dynamic is summed up in Figure 11 with the potentially potent combination of **chronic labour market imbalances, chronic fiscal imbalances and severe income disparity**. When amplified by extreme demographic pressures, these conditions could lead to a retrenchment from globalization and the emergence of a new type of critical fragile states – formerly wealthy countries that descend into a spiral of decay as they become increasingly unable to meet their social and fiscal obligations.

The signs already exist that the world is becoming more fragmented, inconsistent and mistrustful; the question is the extent to which these developments could lead to a global dystopia.

Trends and Uncertainties

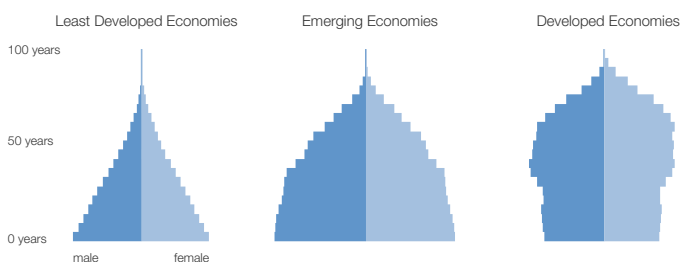
By 2050, the world will experience a near doubling of the urban population to 6.2 billion – 70% of the projected world population of 8.9 billion. This means that we will have to build the same urban capacity (housing, infrastructure and facilities) in the next 40 years that we have built over the past 4,000 years.¹ Meanwhile, the number of people globally over 60 years of age has risen from 8% in 1950 (roughly 200 million people) to 11% in 2009 (760 million people), but is now projected to double in rate by 2050 (2 billion people). Globally, the population of older people is growing at a rate of 2.6% per year, considerably faster than the population as a whole. This rate is projected to grow annually less than 1% over the next 10 years,² and the trend is not confined to developed economies. The percentage of people between the ages of 10 and 24 has already begun to decline in many emerging countries.³ Figure 12 provides a snapshot of the projected population age distributions in 2025.

Meeting social contracts for the youth and elderly depends on the resumption of strong growth in the global economy, which shrank by 2% in 2009. Within a two-year period following the liquidity crisis, 27 million people around the world lost their jobs; many more accepted reduced working hours, wages and/or benefits.⁴ Young people have been hit especially hard by the lack of career opportunities – a trend that prompted the International Labour Organization to warn of a “lost generation”. Since the onset of the global recession, many countries have experienced increases in rates of poverty, mental illness, substance abuse, suicide, divorce, domestic violence and the abandonment, neglect and abuse of children.⁵

On an unprecedented scale around the world, there is a sense of receding hope for future prospects. Gallup polling data in 2011 reveal that, globally, people perceive their living standards to be falling, and they express diminishing confidence in the ability of their government to reverse this trend. Their discontent is exacerbated by the starkness of income disparities: the poorest half of the global population owns barely 1% of the global wealth, while the world’s top 1% owns close to half of the world’s assets.⁶ Figure 13 provides a global snapshot of inequality, while Figure 14 shows a rise in inequality across many developed economies.

Figure 12: Population Imbalances in 2025

Population pyramids showing the percentage of the population using 4-year age intervals



Source: Data from *World Population Prospects: 2010 Revision*. New York: United Nations Department of Economic and Social Affairs, 2010.

¹ World Economic Forum. *Outlook on the Global Agenda*, 2011.

² United Nations. *World Economic Situation and Prospects 2010*.

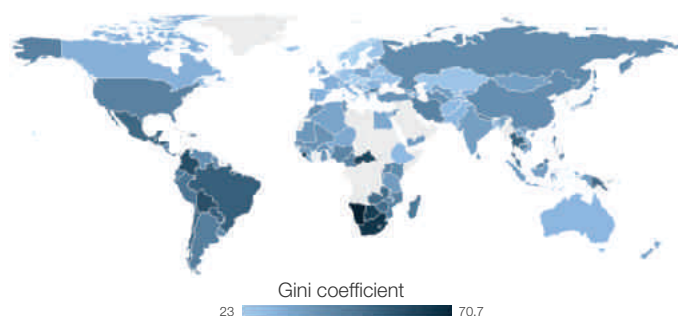
³ United Nations Department of Economic and Social Affairs, *World Population Prospects: 2010 Revision*. 2010. New York: United Nations Department of Economic and Social Affairs.

⁴ International Labour Organization. *World of Work 2011*. Geneva: International Labour Organization.

⁵ United Nations, Department of Economic and Social Affairs. “*The Global Social Crisis*”, *Report on the World Social Situation 2011*.

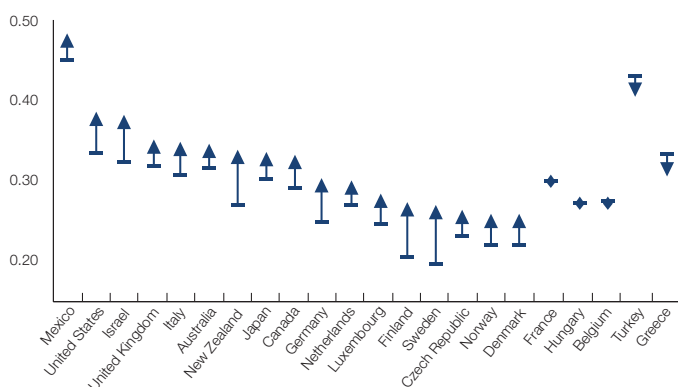
⁶ Credit Suisse. “*Global Wealth Report*”, Research Institute, 2011.

Figure 13: Income Inequality



Source: World Bank, Open Data, <http://data.worldbank.org/>

Figure 14: Incomes in Many Developed Economies are Less Equal Than They Used to Be



Source: *Growing Income Inequality In OECD Countries: What Drives It and How Can Policy Tackle It?* Paris: OECD, 2011.

Equally striking contrasts are emerging within national borders; for example, residents of Shanghai now live an average of 15 years longer and earn US\$ 20,000 per year more than their fellow Chinese citizens in the inland province of Guizhou.⁷ Gross inequality is not a new phenomenon, but the fact that this year's survey respondents selected **severe income inequality** as the most likely global risk to manifest in the next 10 years suggests that concern about its consequences is growing.

In developed countries, household and national debts compound the challenge of providing for ageing populations. On average, households in emerging economies owe 30% of their annual income, while households in developed economies owe almost 150%, or 1.5 years, of their income.⁸ Shrinking tax revenues have deteriorated the fiscal positions of governments and reduced their ability to ease social hardship with welfare and counter-cyclical spending.

While ageing populations and economic slowdown put pressure on social contracts in advanced economies, in emerging economies there is a growing demand to formalize social contracts. India's National Rural Employment Guarantees Act and Brazil's Plano Brasil Sem Miséria are examples of new government programmes that aim to redistribute wealth and guarantee incomes in an effort to fight poverty and inequality. However, like welfare systems in developed economies, these programmes depend on continued growth and expanding employment and are therefore vulnerable to economic contraction.

In 2011, the World Economic Forum launched its quarterly Global Confidence Index. The final results show that over half the

respondents remained pessimistic about the global economic outlook; one in four said there is a lack of global leadership to deal with global problems. A majority fear greater geopolitical as well as societal upheaval in the years to come.⁹

Key Insights

General expectations about the potential of the world economy may not be met due to the interplay between fiscal imbalances and demographic trends. The resulting disappointment is amplified by a growing sense that wealth and power are becoming more entrenched in the hands of political and financial elites. Though rapid urbanization offers economies of scale if infrastructure keeps pace, it also makes the gulf in living standards between the rich and the poor more immediately visible to more people – a trend which is further amplified by the Internet.

When social mobility is widely perceived as attainable, income disparity can spur people to reach for success. However, when ambitious and industrious young people start to feel that, no matter how hard they work, their prospects are constrained, then feelings of powerlessness, disconnectedness and disengagement can take root. The social unrest that occurred in 2011, from the United States to the Middle East, demonstrated how governments everywhere need to address the causes of discontent before it becomes a violent, destabilizing force.

The world has at its disposal the human resources to manage its ageing populations and to ensure that scores of youth do not feel that the opportunities presented by economic growth are beyond their reach. While the problems manifest themselves differently across developed, emerging and least developed economies, the experts contributing to this report suggest that their solutions may be surprisingly similar: equip youths with the skills to succeed and enable them to move to where their labour is most needed through safe, well-managed migration channels.

Dangers arise, however, when the necessary leadership is not forthcoming, and populations are not equipped with the skills to adapt to new realities. As a result, a vicious cycle could take hold: as tough times feed disillusionment, populations may retreat from global connectedness, which in turn will limit the ability to arrest a potential slide into dystopia.

Questions for Stakeholders

- How can countries collaborate more effectively to correct chronic labour imbalances?
- What will social contracts be like in 2022? How can unemployed workers be better trained for the skills required?
- What steps can be taken to reduce income disparity?
- What measures should be undertaken today to deal with the changing socio-economic dynamics of an ageing population and bulging young population?
- How can fostering entrepreneurship prevent the seeds of dystopia from taking root?

⁷ "Gapminder". Gapminder World, <http://www.gapminder.org/>, 2011.

⁸ Credit Suisse. "Global Wealth Report", Research Institute, 2011.

⁹ According to the *Global Confidence Index* of the World Economic Forum, perspectives outside the private sector were the most bearish, with almost 54% of the respondents indicating that they are not confident in the state of the global economy. Just over 40% expressed little confidence in the economy in 2012.

Case 2:

How Safe are our Safeguards?

Analysis of the Global Risks Survey revealed that the risk of **unintended negative consequences of regulations** was tightly connected with many other global risks. This indicates far-reaching weaknesses in regulations and suggests that we may be falling behind in our capacity to protect the systems that underpin growth and prosperity. For safeguards to strike the right balance – neither so lax they fail, nor so strict they carry harmful consequences – we need a more flexible, forward-looking approach. This applies to a diverse range of topics, such as global finance, transportation networks, emerging science and new technologies, scarce resources, the climate and biodiversity. Existing processes for setting regulations tend to focus on specific industries, sectors or actions, and are often over-complicated, inadequate, fragmented and slow to respond to the accelerating pace of global change. A shift in mentality is called for, so that policies, regulations or institutions can offer vital protection in a more agile and cohesive way.

Risk Constellations and Potential Impacts

On 14 April 2010, a cloud of volcanic ash spread from Iceland across the skies of Northern Europe. The grounding of thousands of flights was ordered by the International Civil Aviation Organization (ICAO) according to safeguards developed after the failure of some jet engines in the 1991 Pinatubo Volcanic Eruption. Initially, this was widely seen as a sensible precaution due to the lack of clarity on how great a risk the ash would pose to flight safety. After only a few days, with millions of people and goods left stranded, airlines and airports facing billions of dollars in losses and the Eyjafjallajökull volcano still spewing ash into the sky, the risk of resuming flights began to seem worth taking. Some airlines sent test flights into the cloud. As they returned without evidence of harm to their engines, an ad hoc process of relaxing the regulations began.

In hindsight, it turned out that the regulations in this case had initially been overly strict. As a result, for a frustrating few days, many people were denied air travel. But, what was the alternative? What if no safeguards had existed, no flights been grounded, the risk had proved real and thousands of people had died as a result of multiple planes suffering engine failure? ¹⁰

Beyond the immediate tragedy, the result could almost certainly have been a collapse in public trust in the safety of flying. In a bid to regain that trust, it is likely that regulators would have felt the need to define new standards that were unnecessarily strict, as the pendulum swings to overcompensate for the last acute shock. Global Risks 2012's Special Report on Japan shows how a similar dynamic played out, as the Fukushima meltdown triggered global public anxiety about nuclear power. This event prompted German politicians to shut down eight of Germany's 17 nuclear reactors immediately, with the remaining nine to be taken offline by 2022.

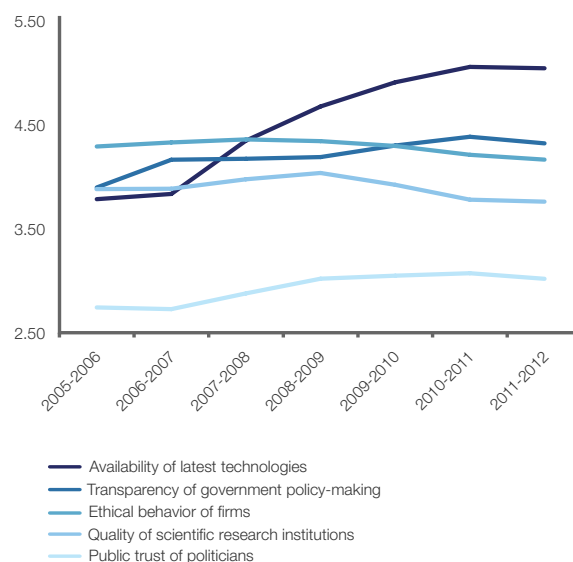
¹⁰ Alemanno, A. *Governing Disasters*. Cheltenham: Edward Elgar Publishing Limited, 2011

Ultimately, the effect of regulatory safeguards which are too lax or too strict becomes the same: the full benefits of adequate industry regulation are undermined and not fully captured. In defining safeguards, the challenge is to reach the right balance by weighing the consequences of catastrophe and the consequences of stifling an industry's development.

Achieving a satisfactory balance is therefore becoming more and more challenging, as the systems on which the global economy relies become increasingly interdependent and complex, with national regulations capable of having unintended repercussions globally. The problem of how much volcanic ash it takes to stall a jet engine is actually relatively straightforward for experts to determine. It is complicated, but not complex, as the ways in which ash can damage engines are well understood. By contrast, a defining feature of a complex system is that causal effects are nonlinear and virtually impossible to predict. Thus, for example, an earthquake that damaged a nuclear power plant in Japan impacted European energy policy. In another recent example, mortgage-backed securities originating in the United States crippled banks around the world.

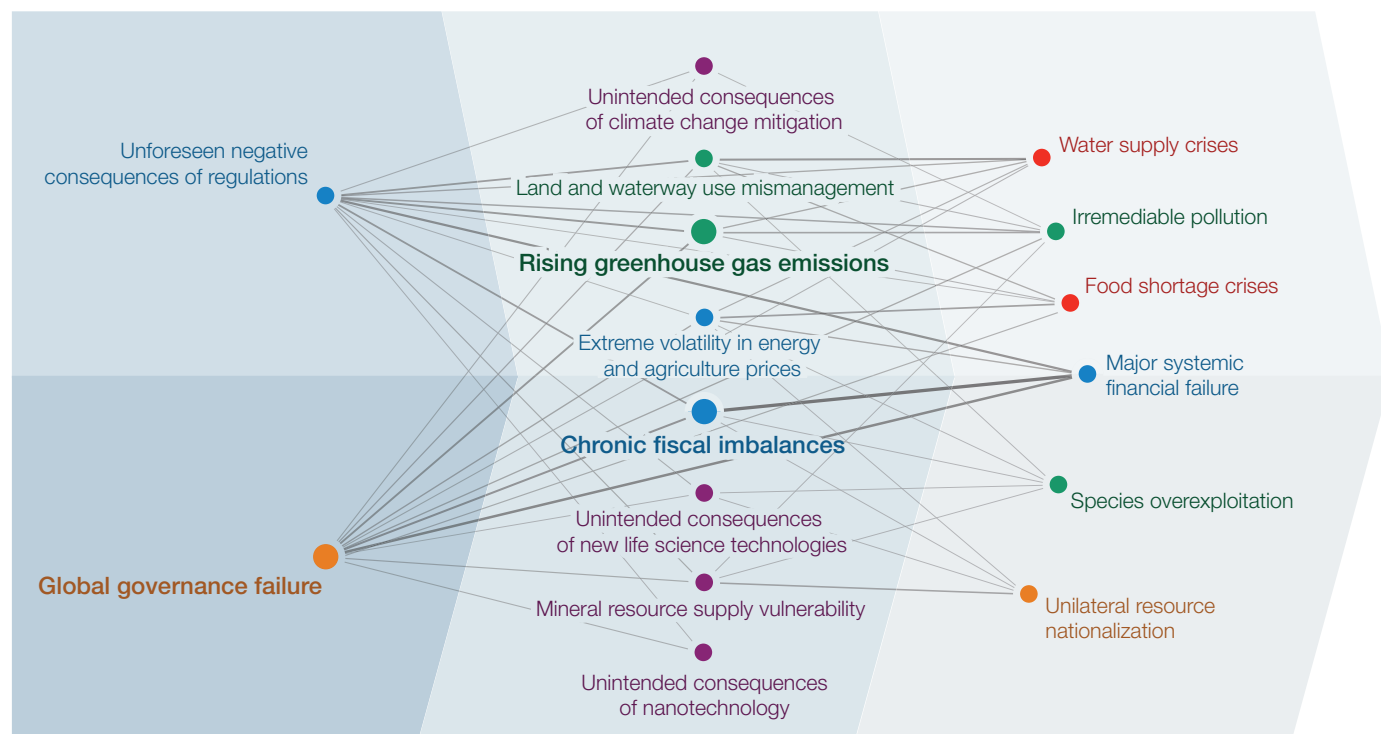
Figure 15: How Safe are our Safeguards?

Data from the World Economic Forum's annual Executive Opinions Survey corroborates findings of the Global Risks Survey. This figure shows that, globally, the latest technologies are increasingly accessible to local industries, but indicators relating to confidence in the institutions responsible for developing safeguards, including those that manage the risks of emerging technologies, have not shown proportionate increases.



Source: World Economic Forum

Figure 16: Unsafe Safeguards Constellation



Origin Risk

Humanity's action to mitigate complex risks fail or cause unintended consequences.

Pathways

Numerous, relatively manageable risks are made worse or unabated due to inadequate safeguards.

Manifestation

These can be exacerbate unmanageable risks. The interconnection between some are well known, for others the end manifestation remains uncertain.

Source: World Economic Forum

Issues such as this typically focus on approaches to the types of regulations. Discussions with the Forum's community of experts revealed that regulations are usually narrowly focused, tailored to specific industries or activities, and aimed to prevent malicious acts, accidents or disasters. The term "safeguards" is used to broaden the scope of the regulatory debate and promote discussion from a systems perspective. In an environment of increased interdependencies, important "secondary" or "spillover" effects also occur beyond any given initial activity, and these consequences must also be monitored. Moreover, regulations themselves can trigger unintended or unforeseen consequences. Despite greater awareness about complex interdependencies, experts feel that there is a growing gap between narrowly-focused regulation and unaddressed diverse secondary system effects.

Analysis of the 2012 Global Risks Survey, as shown in Figure 16 revealed a deep concern about the consequences of getting the balance wrong when defining safeguards for the systems on which we depend. **Unforeseen negative consequences of regulation** emerged as a Critical Connector – nominated by survey respondents as the most important connection to a range of risks, from fiscal imbalances and land and waterways mismanagement, to greenhouse gas emissions and the trajectory of nanotechnology and life sciences innovations.

The common thread linking all the safeguard issues, according to experts, is that decision-makers need to devote more attention and resources to defining the policies, norms, regulations and institutions through which we manage them. While respondents perceived unforeseen negative consequences of regulation as being a lower-impact risk relative to others, analysis suggests it should be acknowledged as a high-priority "origin" risk, owing to the dense web of links connecting it to other global risks with catastrophic impacts.

Trends and Uncertainties

Approaches that have previously been used to respond to risks are becoming increasingly inadequate, given the complexity of systems. Conventionally, nation states have adopted a "predict-and-control" approach, which relies on tools such as regulations, incentives and chains of command. Regulatory agencies often exercise a precautionary approach by not approving specific activities in situations where the threat is uncertain. When the potential benefits from the activity are large, this practice may not provide the right balanced approach if the smallest doubt exists on safety.¹¹

The obvious limitations of the precautionary approach have led to wider use of impact assessments, which weigh the costs, benefits and risks of any proposed regulation through tools such as scenario planning. However, the focus is usually on reducing the harms that existing or proposed policies from one sector have on another (transport or health for example), rather than focusing on building the resilience of systems and monitoring emerging risks in general.¹²

More promising is the approach of "anticipatory governance." In this model, regulators accept the impossibility of anticipating the potential trajectory of innovations based only on past experience. They embrace the need for dynamic safeguards that can evolve with the system they are safeguarding. Anticipatory governance implies

close, real-time monitoring in the direction in which innovations evolve, and involves defining safeguards flexible enough to be continually tightened or adapted in response to emerging risks and opportunities. The model of anticipatory governance is attracting attention in fields ranging from climate change to personalized medicine.

Key Insights

To improve management of uncertainty in a complex world, it is necessary to accept that we will not get safeguards right the first time. Regulations have often been viewed as a way for authorities to signal to the public that they are in control of a situation, but in a complex system this control is often an illusion. While we should start by considering counterfactuals in order to anticipate possible outcomes of regulations, it is even more important to define broader system safeguards. Such safeguards need to be flexible and dynamic enough to adapt to changing information and should closely involve stakeholders in the co-production of new types of regulation.

The reaction to the volcanic ash cloud is one illustration of this: although the ICAO faced harsh criticism from airline companies for their slow response to new information, it took only a few days for an iterative process of information exchange between the regulators and the airlines conducting test flights for the regulations to be amended. As new knowledge arrives, it becomes possible to continually reassess the balance between the potential consequences of catastrophe and the consequences of stifling a beneficial activity.¹³ Such a dynamic process of iteration between regulators and practitioners at the cutting edge of knowledge exemplifies how safeguards should ideally be defined.

At the heart of this process is a necessary understanding of who bears the risks and who reaps potential benefits, so that incentives can be aligned in an appropriate manner. By their nature, the costs involved in implementing safeguards, such as quality standards and risk mitigation practices, may give some individuals, firms or organizations reasons to lobby to minimize them and look for ways around them. When losses can be passed onto others – as when banks are defined as "too big to fail" – excessive risk-taking is likely to occur. Conversely, when stakeholders recognize the importance of having others adhere to safeguards to protect their own interests, incentives are designed to entice everyone in the system to cooperate. For example, because every plane crash undermines public confidence in flying, firms in the industry are aligned to support activities common to all airlines, such as baggage inspection at airports. Studies show that in some cases the adoption of practices by a subset can reach a tipping point whereby firms all voluntarily adopt them.¹⁴

In defining regulations, it is necessary to avoid regulatory arbitrage. Without global mechanisms to agree on safeguards, dangerously lax ones, even in one jurisdiction, could trigger a global catastrophe – for example, the creation and release of toxic nanoparticles. However, the impossibility of predicting the effects of regulations in complex systems also implies a need for an iterative and incremental learning process. Such a process should exist among a variety of local regulatory environments rather than within a rigid global regulatory monoculture.

¹¹ Meyer-Emerick, N. "Public Administration and the Life Sciences: Revisiting Biopolitics". *Administration & Society*, 2007, 38: 689-708. <http://aas.sagepub.com/content/38/6/689>.

¹² For extensive examples of how impact assessments are being applied by the European health sector to better manage risks whose determinants lie beyond the health sector's jurisdiction, see Wismar, M., Blau, J., Ernst, K. and Figueras, J. *The Effectiveness of Health Impact Assessments*. World Health Organization, 2007

¹³ Alemanno, A. *Governing Disasters*. Cheltenham: Edward Elgar Publishing Limited, 2011.

¹⁴ For a simulated example of this tipping point using airline industry data, see Heal, Geoffrey G. and Kunreuther, Howard H. "IDS Models of Airline Security". *Journal of Conflict Resolution*, 2005, 49: 201-217.

There is, therefore, a need to find a balance that enables jurisdictions to learn from each other's mistakes on a controlled scale – a balance that facilitates learning from trial and error but avoids a situation in which one error could be catastrophic. In striking this balance, it will be crucial for the various authorities defining safeguards to communicate closely, collaborate and share knowledge.

The pursuit of diverse approaches to safeguarding against the same or similar catastrophes or catastrophe-generating activities allows jurisdictions to learn from each other's mistakes on a controlled scale. This approach offers an effective way to diversify regulatory risk and prevent regulatory imbalance in one regime from adversely affecting the system as a whole. Communication and collaboration are critical in the development of safeguards to ensure that knowledge is captured and shared with the global community.

Defining safeguards to build the resilience of complex systems can begin by addressing “known unknowns” – those gaps in our knowledge of which we are aware. One way to do this is through creative processes and applied imagination. For example, the Risk Response Network is building an archive of “what if?” interviews that record hypothetical scenarios as imagined by global opinion leaders and experts to push the boundaries of our world view.

Often there is consensus about what risks do exist, but decisive action is needed to design safeguards before the risks manifest themselves. For example, the World Economic Forum Annual Meeting in 2006 and Global Risks 2007 identified the factors underlying the subsequent global economic recession (see Box 2).

While rarely used in current regulatory models, complex systems theory has the potential to inform the dynamic development of safeguards by helping define mechanisms for detecting patterns in a system. It is also important to pay more attention to modelling the cognitive biases of leaders and the public, such as the tendency to overvalue recent experience. These biases are known to influence decision-making processes. Awareness-raising and training those responsible for defining safeguards would be a first step towards a flexible, systemic safeguard approach.

Box 2: From the Archives

Global Risks 2006: Complexity and Resilience, World Economic Forum Annual Meeting 2006

The economic risks group's biggest job was to “break through the complacency”, according to the presenter. Most members of the group felt pretty confident about the global economy, he said. And when part of the group considered some threat important, another countered that the solution was at hand. Nevertheless they came up with a list of concerns:

1. Asset bubbles and the massive misallocation of capital (e.g., the US property market)
2. Oil, the short term spike and possibly high or volatile prices in the long term
3. A global current account imbalance
4. China's possible troubles in the banking system and geopolitical tensions
5. A fiscal crisis in the industrialized countries

While the risks might seem manageable when examined individually, they could be troublesome should they hit in tandem. “I can see combinations that could threaten globalization,” said one panellist.

Questions for Stakeholders

- How can leaders break the pattern of crises followed by reactionary regulation and develop anticipatory and holistic approaches to system safeguards?
- How can appropriate regulations be developed so that firms will undertake effective safeguards?
- How can businesses and governments prevent a rapid breakdown in trust following the emergence of a new widespread risk?
- How can business, government and civil society work together to improve resilience against unforeseen risks?

Case 3:

The Dark Side of Connectivity

The critical infrastructure¹⁵ that underpins our daily lives increasingly depends on hyperconnected online systems. While significant resources have historically been needed to cause devastating consequences for geopolitical or corporate powers, it is increasingly possible for skilled individuals to do so remotely and anonymously through networked computer systems. As power shifts from the physical to the virtual world, a new paradigm for ensuring a healthy digital space must emerge. This case highlights the importance of redressing the misaligned incentives which stand in the way of a healthy future for critical information infrastructures. Online security is a public good, and new mechanisms are urgently required to secure private investment in exploring existing system vulnerabilities before they can be exploited.

Risk Constellations and Potential Impacts

In the last decade, the ubiquity of the Internet has transformed the ways in which we conduct business, personal relationships and even popular uprisings, as illustrated most recently by those in North Africa. However, new ways of operating bring new kinds of vulnerability. Today, there is a sense that we understand the benefits of the Internet more fully than we understand the risks. Terrorism, crime and war in the virtual world have, so far, been less deadly and disruptive than their equivalents in the physical world, but there is a growing fear that this could change. Will the dark side of connectivity become an amplifying factor for traditional security risks in the next decade?

Views of experts are mixed. There is not much empirical evidence. Research into cyber threats against governments and the private sector has largely been funded by those who are in the business of selling internet security solutions – a potential bias that causes scepticism. Academic and policy papers are based largely on anecdotal case studies. This report looks forward over a ten-year horizon, and it is wise to bear in mind that much can change during that time. Only 10 years ago, the dot-com bubble burst, and claims about the Internet's potentially transformative benefits seemed to have been wildly overstated. We can now see that they were not so much overstated as premature. It is worth considering whether the same could prove to be true of current alerts about the Internet's potentially transformative risks.

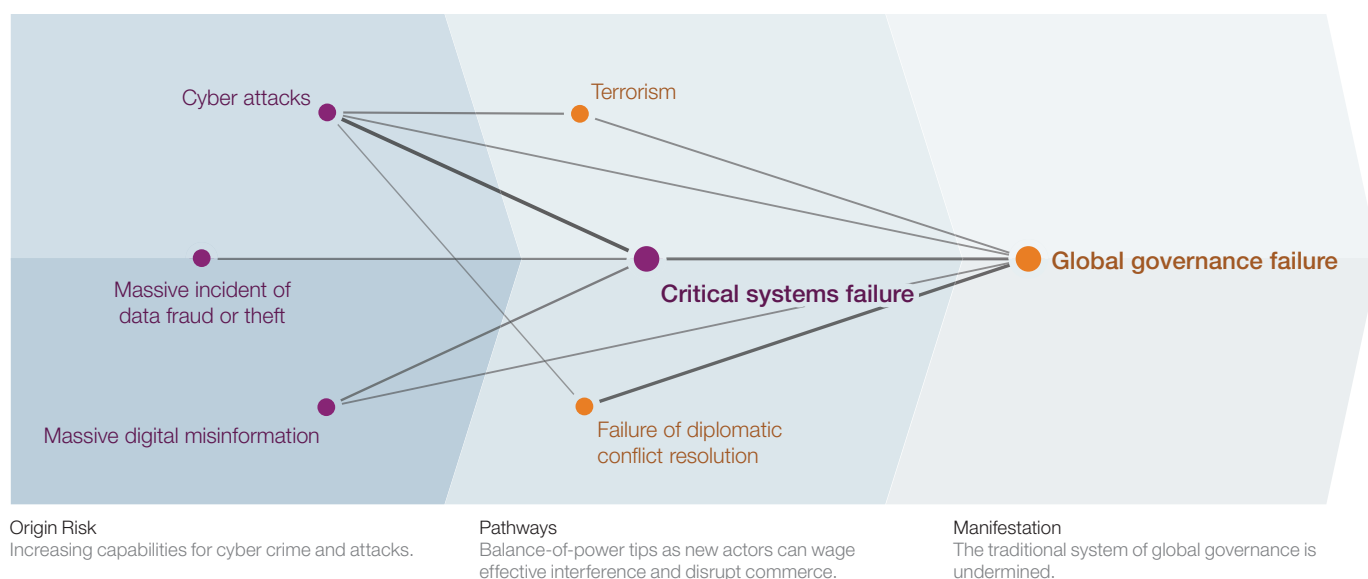
Analysis of survey responses showed that **critical systems failure** was rated as the Centre of Gravity in the technological category. Respondents considered the risk that a single vulnerability could trigger cascading failures of critical infrastructures and networks as having relatively low likelihood but high impact. The risk that respondents most frequently connected to critical systems failure was **cyber attacks**. Clearly, concern over this issue is high; however, the technological category was notably the only one in which experts tended to give lower impact and likelihood assessments than the non-technology respondents. This was reversed in the other four categories, where experts tended to show more concern than the rest of survey respondents (see Appendix 2 for more details). Figure 17 depicts a constellation of global risks related to cybercrime and systems disruption that could amplify traditional security concerns, such as the breakdown of diplomatic conflict resolution and terrorism. This cascade could eventually undermine global governance.

Cyber threats come in three categories that are familiar to military strategists and intelligence analysts: sabotage, espionage and subversion. Examples are shown in Box 3.¹⁶ The real world

¹⁵ Critical Infrastructure includes electricity, water, gas, transport, and information and communications technologies.

¹⁶ Adapted from Greer, K. "Strategic Cyber Security". NATO Cooperative Cyber Defence Centre of Excellence, <https://media.defcon.org/dc-19/presentations/Geers/DEFCON-19-Geers-Strategic-Cyber-Security-WP.pdf>, 2011

Figure 17: The Dark Side of Connectivity Constellation



Source: World Economic Forum

consequences of virtual world attacks can range from mundane petty crime and mischief-making to shutting down critical systems, or even potentially triggering physical armed warfare. Unlike traditional forms of attack in the physical world, the motives and true goals of cyber attacks – which can be carried out remotely and with near-impenetrable anonymity – can be more difficult to analyse.

Successful acts of sabotage require the greatest resources and technical sophistication – so much so that most experts consider them currently attainable only by highly organized and well-resourced actors such as nation states. A recent example of cyber sabotage is the Stuxnet virus, a malicious code that attacked a specific piece of IT equipment – the Siemens controllers used in nuclear facilities in Iran. Experts believe that the creation of Stuxnet required a team of software developers and intimate knowledge of the stringent security measures built into the target's design and operation.¹⁷

While evidence of the impacts of Stuxnet are questionable – it may have delayed the Iranian nuclear programme's development, which is assumed to have been its goal – its broader significance lies in suggesting what is possible. A virus like Stuxnet could conceivably trigger a meltdown in a functioning nuclear power plant, turn off oil and gas pipelines or change the chemical composition of tap water.

Cyber espionage also involves a relatively high level of technical sophistication and is currently believed to be restricted to major corporations, nation states and elite hackers. One example is GhostNet, a cyber tool discovered in 2009 to have infected over a thousand computers in ministries of foreign affairs, embassies, international organizations, news media and non-governmental organizations in 130 different countries. The virus could send documents from infected hard drives back to its creator, record keystrokes as users typed at the keyboard, and even covertly activate the computer's camera and microphone.

At the lowest end of the scale of technological sophistication is subversion, which can severely damage reputations and undermine trust. For example, in 2011 the US technology security firm HBGary Federal – whose clients include the US Government and McAfee – claimed to have information on the identities of a notorious group of activist hackers, or “hacktivists”, known as Anonymous. In response, Anonymous infiltrated HBGary's servers, slandered them on their own website, published 40,000 of the company's private emails, took down their phone system, took over their chief executive officer's Twitter account and posted his social security number online.¹⁸ While this attack was motivated by revenge, the motives for subversion can be as trivial as simple boredom.¹⁹

Box 3: Objectives of Cyber Attacks

Sabotage

- Users may not realize when data has been maliciously, surreptitiously modified and make decisions based on the altered data. In the case of advanced military control systems, effects could be catastrophic.
- National critical infrastructures are increasingly connected to the Internet, often using bandwidth leased from private companies, outside of government protection and oversight.

Espionage

- Sufficiently skilled hackers can steal vast quantities of information remotely, including highly sensitive corporate, political and military communications.

Subversion

- The Internet can spread false information as easily as true. This can be achieved by hacking websites or by simply designing misinformation that spreads virally.
- Denial-of-service attacks can prevent people from accessing data, most commonly by using “botnets” to drown the target in requests for data, which leaves no spare capacity to respond to legitimate users.

¹⁷ Rid, T. “Cyber War Will Not Take Place”. *Journal of Strategic Studies*, 2011, 1-28. <http://www.tandfonline.com/doi/pdf/10.1080/01402390.2011.608939>

¹⁸ Hactivism is a new way that the public can express discontent. As with traditional forms of demonstration, non-violent methods are preferred. This issue is explored further below.

¹⁹ “Cyber Security”. *Financial Times*. Special Report. 1 Nov 2011. <http://www.ft.com/intl/cms/3ea54958-041b-11e1-864e-00144feabdc0.pdf>.

Experts believe that this kind of subversive attack – embarrassing and inconvenient, but rarely life-threatening or catastrophic – currently represents the limits of skilled individuals bearing a grudge. However, barriers for committing more serious acts of espionage and sabotage are lowering all the time. In November 2011, four people were arrested in the Philippines in connection with the hacking of several US telecommunications companies that resulted in losses of US\$ 2 million for AT&T alone, and these funds were diverted from the phone companies to accounts of known terrorism financiers.²⁰ While many experts downplay concerns about “cyber war” between geopolitical powers, others point to several states that are known to be devoting significant resources to developing cyber weapons and defences. In 10 years, Stuxnet and GhostNet could look as crude and primitive as websites during the dot-com bubble would look to us today.

Trends and Uncertainties

Individuals, businesses and nation states are depending more and more heavily on data and systems in the virtual world. Thirty-five per cent of the global population is online, up from 8% just 10 years ago (see Figure 18).²¹ The way we connect is also changing: at the end of 2011, about 470 million smartphones had been sold worldwide, and the number is projected to double by 2015.²² Figure 18 shows projected growth in connectivity of people through the Internet, but perhaps the more significant shift lies in the rapid growth in “the internet of things” – the high-speed communications network composed of electronic devices rather than people (see Figure 19). Currently there are five billion devices or “things” connected and remotely accessible through the internet, from cars, kitchen ovens and office copiers, to electrical grids, hospital beds, agricultural irrigation systems and water station pumps. The number of devices connected on the internet is expected to reach 31 billion in 2020.²³

Many potential benefits are obvious. For example, smart meters monitor use of domestic electricity consumption and feed this information back to providers, who can use it to make management of electricity supply significantly more efficient. The result saves money and reduces greenhouse gas emissions. The downside is that, once an information link is created between a user’s electricity meter and the grid, there is a theoretical risk of a user being able to hack into the grid via their meter and sabotage an area’s electricity supply. Connectivity also allows for amplification; attacks that would have been isolated incidents in the physical world can achieve a cascading effect through connectivity.

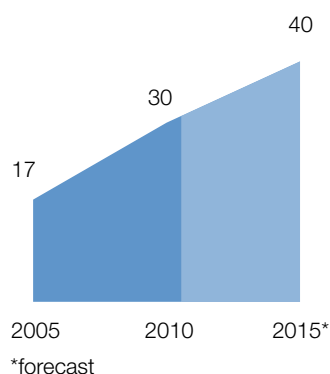
Businesses are increasingly worried about targeted attacks which aim to sabotage or steal data from their systems. These so-called “advanced persistent threats” (APT) are driving corporate information security spending globally.²⁴ Companies are increasingly aware of cyber threats but are not necessarily sure how to address them. A recent study reported that companies feel both more informed about cybercrimes, but less confident in their existing cyber security measures than ever before.²⁵

Reliable indicators of the financial impact of cyber attacks are hard to come by. Most reports reference the same figures – those

provided by the Ponemon Institute²⁶ – which estimated the cost of crime for a sample of 50 large US companies would increase 44% between 2010 and 2011. The median cost of those attacks was US\$ 5.9 million per year, an annual increase of 56%. Figure 20 suggests that cyber risks constitute a significant threat to businesses, but more information is needed to allow businesses to gauge the extent of the risk since many remain un- or under-reported.

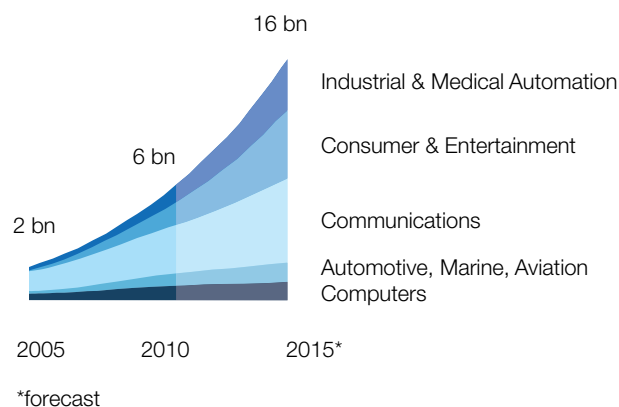
It is possible that the impact of cybercrimes on companies goes under-reported, as victims prefer not to disclose that their systems have been compromised. However, the fact that cybercrime is more frequently in the news suggests this is changing. There is a growing market for cyber risk insurance, covering risks ranging from computer security liability to business interruption, cybercrime and cyber extortion. The annual gross written premium for cyber risk-related insurance is US\$ 500 million, with the market so far mostly in the United States.²⁷ This is projected to grow over the next decade, especially due to recent regulatory and legal changes. For example, the US Securities & Exchange Commission (SEC) guidance released in October 2011 indicated that a computer breach should be viewed as a potential material event requiring disclosure regardless of whether the breach involved release of confidential data or not. The European Union and Asia have begun to adopt similar breach notice laws.²⁸

Figure 18: Increasing Connectivity, Internet Users Per 100 People



Source: “World Telecommunication/ICT Indicators Database 2010”. International Telecommunication Union, <http://www.itu.int/ITU-D/ict/publications/world/world.html>, 2011.

Figure 19: The Internet of Things



Source: Gantz, J. “The Embedded Internet: Methodology and Findings”. IDC, <http://download.intel.com/embedded/15billion/applications/pdf/322202.pdf>, 2009.

²⁰ Schwartz, M. “AT&T Hackers Have Terrorism Ties, Police Say”. *Information Week*, 28 Nov 2011. <http://www.informationweek.com/news/security/attacks/232200252>; Sengupta, S. “Phone Hacking Tied to Terrorists”. *The New York Times*, 11 Nov 2011. <http://www.nytimes.com/2011/11/27/world/asia/4-in-philippines-accused-of-hacking-us-phones-to-aid-terrorists.html>.

²¹ “World Telecommunication/ICT Indicators Database 2010”. International Telecommunication Union, <http://www.itu.int/ITU-D/ict/publications/world/world.html>, 2011.

²² Nagamine, K. “Worldwide Smartphone Market Expected to Grow 55% in 2011 and Approach Shipments of One Billion in 2015”. International Data Corporation, <http://www.idc.com/getdoc.jsp?containerId=prUS22871611>, 2011.

²³ “The Internet of Things Backgrounder”. Intel, <http://newsroom.intel.com/servlet/JiveServlet/download/2297-55895/The%20Internet%20of%20Things%20Backgrounder.pdf>, 2011.

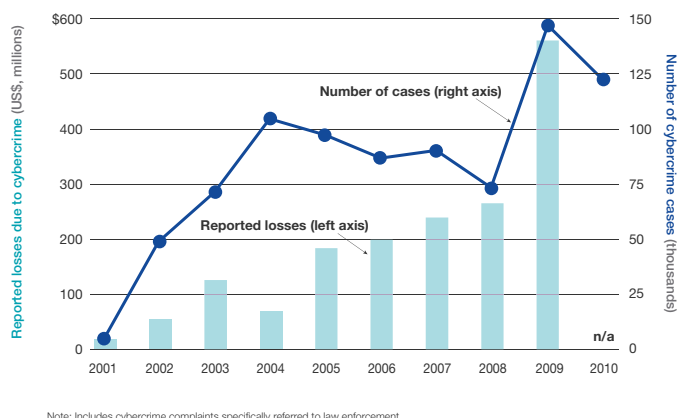
²⁴ PricewaterhouseCoopers. Survey 2011.

²⁵ Ibid.

²⁶ *First Annual Cost of Cyber Crime Study*. July 2010. Ponemon Institute; *Second Annual Cost of Cyber Crime Study*. Aug 2011.

²⁷ Analysis from Marsh Inc.

²⁸ Ibid.

Figure 20: Cost and Incidence of Cybercrime in the US

Source: PwC, 2011

Key Insights

A key challenge in minimizing the risks from the dark side of connectivity is that incentives are misaligned. Vendors of online security products have an interest in talking up the threats of cybercrime, while victims of cybercrime often have an interest in remaining silent. It is therefore very difficult for firms and organizations to get a clear picture of the true levels of the risk and needs for investment. Correcting such information asymmetries should be at the centre of policies to improve global cyber security and to ensure an efficient market.

Online security is also an example of a public good; costs are borne privately, but benefits are shared. When individuals weigh the cost of investing in antivirus software, they do not take into account the benefits of protecting other users from spam and advanced persistent threat attacks if their computers are infected with malware. Firms have an incentive to invest in cyber security measures that protect their own interests, rather than in those measures that contribute to the health of the overarching critical information infrastructure. Innovative multistakeholder collaboration will be required to tip the balance towards investment in creating systemic resilience.

Efforts to tackle the dark side of connectivity need to accept the fundamental axioms noted in Box 4.²⁹ There are no proven secure systems, only systems whose faults have not yet been discovered, so trying to overcome “hackability” may be as hopeless as denying gravity. Instead, the goal should be finding ways for well-intentioned individuals to identify those faults and deploy remedies to end-users before would-be cyber criminals can discover and exploit them. Experts believe that the levels of resource devoted to this effort are nowhere near adequate, but there are signs that some industries are taking cyber threats more seriously. In November 2011, 87 banks in England participated in a mock cyber attack “stress test” in preparation for an anticipated increase in attacks during the 2012 Summer Olympic Games.³⁰

One example of an innovative market solution is Facebook’s “bug bounty” initiative, which allows individuals who hack into Facebook’s systems to report how they did so to the company and receive a reward.³¹ Facebook’s strategy is controversial among software developers and firms who see it as legitimizing efforts to abuse proprietary software. However, without legitimate markets to turn to, individuals who are skilled at discovering bugs in software are drawn to the thriving black market in “zero-day exploits”, where pieces of code that exploit vulnerabilities in software applications can sell for hundreds of thousands of US dollars.

Understanding and working with human motives in this way is essential to defining both challenges and successful solutions. Many people who would be ashamed to admit stealing a DVD from a shop will happily discuss illegally downloading a movie. We need more research to understand why social norms that curtail actions in the physical world may be less powerful in the virtual world, and how to change this. A frank discussion is also needed on the rules of acceptable engagement for corporate and industrial espionage, especially where the line between private and public enterprise is blurred. In addition, further dialogue could clarify the extent to which “hacktivist” movements can be accommodated as a virtual expression of legitimate civil disobedience.

Box 4: Axioms for the Cyber Age

Any device with software-defined behaviour can be tricked into doing things its creators did not intend.

Any device connected to a network of any sort, in any way, can be compromised by an external party. Many such compromises have not yet been detected.

Questions for Stakeholders

- What steps can be taken to improve the sharing of information and to construct appropriate safeguards to reduce cyber threats in the coming decade?
- What incentives will effectively mobilize businesses and the public sector to invest in the resilience of critical information infrastructures?
- How can we reconcile the potential benefits of innovations created through open source software with the risk that some individuals may manipulate the code for malicious purposes?
- Is online anonymity an integral aspect of freedom in a hyperconnected world?

²⁹ Adapted from Schneier, B. *Secrets and Lies*, 2000.

³⁰ Evans, S. “UK banks stress test defences against cyber attack”. *Computer Business Review*, 23 Nov 2011. <http://security.cbronline.com/news/uk-banks-stress-test-defences-against-cyber-attack-231111>.

³¹ Segall, L. “Facebook pays \$40,000 to bug spotters”. *CNN Money*, 30 Aug 2011. http://money.cnn.com/2011/08/30/technology/facebook_bug_bounty/index.htm.





Special Report: The Great East Japan Earthquake

At 14.46 on 11 March 2011, a 9.0-magnitude earthquake struck the Tohoku region of northeastern Japan and caused a tsunami that hit the country's coastline within half an hour. Waves estimated as high as almost 40 metres (roughly 16 storeys) inundated an area of more than 500 square kilometres, taking the lives of nearly 20,000 people, ruining the lives and livelihoods of thousands of others and destroying over 100,000 buildings.³²

³² "National Police Agency figure". <http://www.npa.go.jp/archive/keibi/biki/higaijokyo.pdf>, 2011.

Figure 21: Resilience Built over Time: Disaster Prevention, Early Warning and Emergency Recovery Response (Extract)

	Year	Dead/ missing	Lessons from the disaster	Policies introduced after the disaster
Nobi earthquake	1891	7,300	Government made aware of the importance of earthquake measures	Disaster prevention investigation committee established; research began into Western methods for earthquake resistant construction
Great Kanto earthquake	1923	105,000	Buildings constructed using Western methods collapsed; large-scale fires from traditional wooden houses	Revised town construction law, with anti-fire planning codes and the world's first earthquake resistance regulations
Miyagi earthquake	1978	28	Concrete apartment buildings thought to be resistant collapsed	Major revision of construction standards; new design law aimed to ensure all new buildings can withstand a seismic intensity 7* earthquake
Hokkaido Nansei-oki earthquake	1993	230	Tsunami arrived before the warning system could function	Shortened forecast time from five minutes to three minutes
Hanshin Awaji earthquake	1995	6,437	98% of buildings that were destroyed were built before the amended construction law; Local government functions disrupted: – Prime Minister not notified for 2 hours – Delayed response by firefighters – Delay in identifying damage – Donations insufficient for rebuilding	Law enacted improving earthquake resistance of existing structures. Rapid top-down response enabled: – Crisis centre established at the PM's residence – Law revised to expedite emergency response – Better observation points to identify damage – Government upped financial support for victims

* Seismic intensity 7 is based on the Japan Meteorological Agency's Intensity Scale, which describes the degree of shaking at a point on the Earth's surface. Unlike the Richter Scale the intensity of an earthquake is not totally determined by its magnitude, and varies from place to place. The effect of an intensity 7 quake on people is described as: to be thrown by the shaking and impossible to move at will, whereas in a 6 it becomes impossible to keep standing and to move without crawling.

Source: Global Agenda Council on Japan, 2011

The quake's magnitude surprised even a country with a long history of earthquakes. Nonetheless, the extensive efforts made over the years by the Japanese Government, businesses and population to develop and strengthen the disaster prevention system limited the death toll from the earthquake itself to under a thousand (Figure 21).

Japan was not, however, prepared for a tsunami of such an unprecedented scale. Over 90% of deaths were due to drowning – with the elderly more than twice as likely to be caught unable to evacuate in time. This fact contrasts with the 1995 Hanshin Awaji earthquake, where 83% of deaths were due to collapsing houses and fire.³³ In particular, those responsible for defining safeguards at the Fukushima nuclear plant had given forethought to the possibility of a tsunami, but with waves only a third the height. Although the reactors themselves automatically stopped the moment the earthquake struck, the cooling system and the backup power generator failed after the plant was hit by the tsunami. The resulting meltdown of three nuclear reactors led to high radiation levels which required the evacuation of more than 60,000 people.

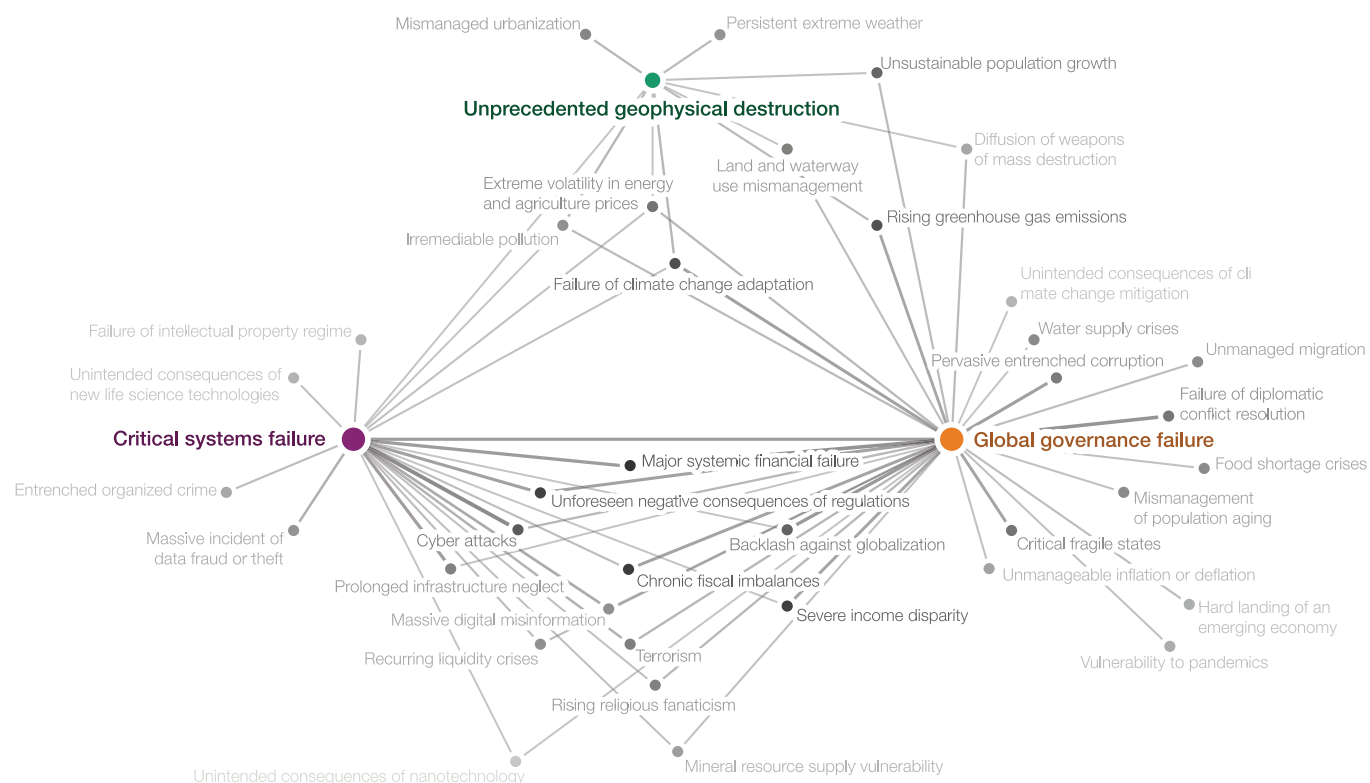
Unforeseen Consequences Ripple through Complex Global Systems

The meltdown at Fukushima reignited public debate about the safety of nuclear power. Politicians in several countries responded by dropping plans for new nuclear facilities. In Germany, for instance, 200,000 citizens took to the streets to protest against nuclear power, and the pro-nuclear party of Chancellor Angela Merkel suffered heavy losses in local elections. In response, the government announced the immediate decommissioning of the country's oldest nuclear plants, with the others to be phased out by 2022.

There was no credible suggestion that the decommissioned or cancelled nuclear plants would have been unsafe, and the energy they would have generated will now have to be generated by other means – most likely involving the burning of gas, which is more expensive and has a larger environmental impact. The fact that inadequately defined safeguards at one outdated nuclear facility in Japan can lead to increased greenhouse gas emissions and higher energy prices in Germany suggests why analysis of survey responses revealed unforeseen negative consequences of regulation to be a Critical Connector.

³³ Funabashi, Y., and Takenaka, H. "The Catastrophe and Comprehensively-Linked Crisis;" Funabashi, Yoichi. "The Political Function: Post Mortem of a Crisis Governance". Forthcoming.

Figure 22: Risk Characteristics of the March 2011 Disaster in Japan



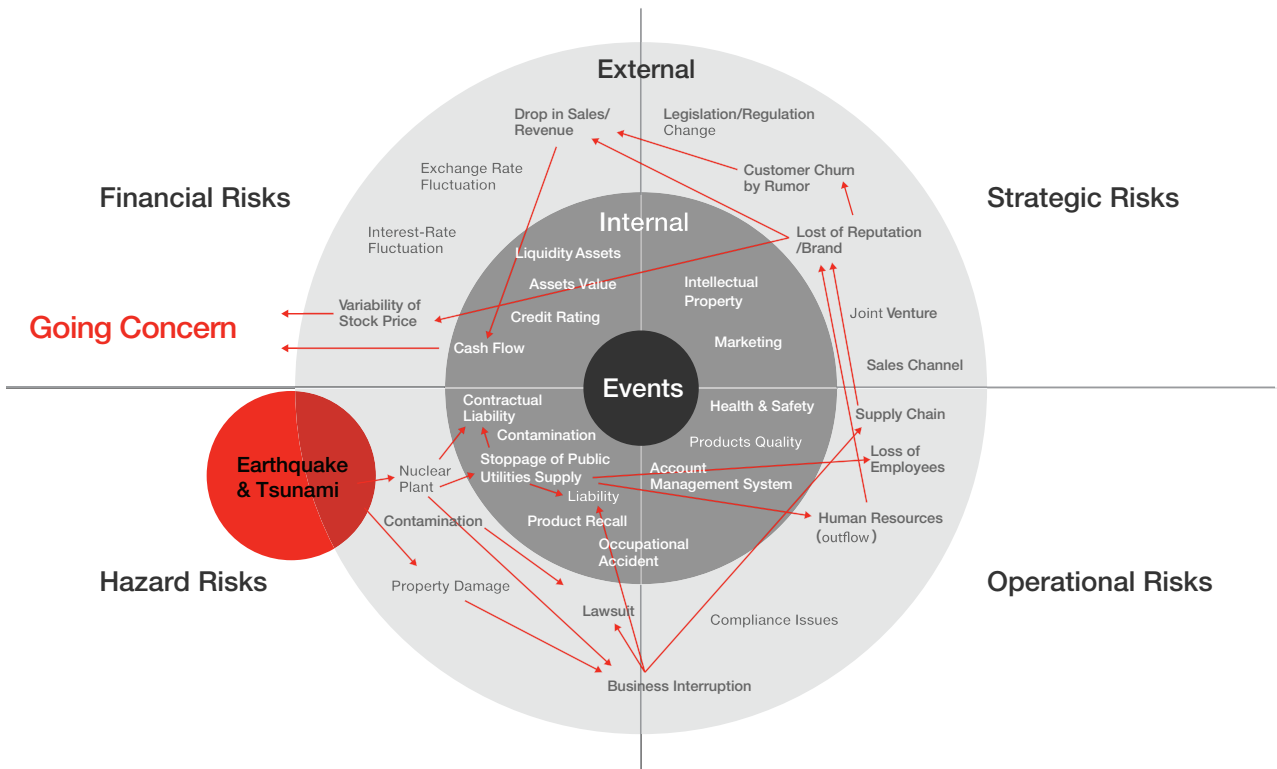
Source: World Economic Forum

The meltdown at Fukushima also challenges the relatively low priority assigned by survey respondents to interconnections between the risk of unprecedented geophysical destruction and two Centres of Gravity: critical systems failure and global governance failure. While the connection between the latter two is perceived by the survey respondents to be strong, as shown in Figure 22, the March 2011 disaster in Japan suggests that survey respondents may have underestimated the systemic relevance of geophysical destruction to these two risks. In particular, the breakdown of the coding system and back-up generator exposed a weakness that could potentially be exploited by a cyber or a physical attack. These risks are closely interconnected to critical systems failure, as explored in Case 3 – The Dark Side of Connectivity – in this report.

As emphasized throughout this report, the systems on which the global economy relies are increasingly complex and interdependent. In such systems, the impact of a novel event is often difficult to predict, and the effects of the tsunami stretched in unexpected directions. The direct impact of the damage incurred is estimated at 17 trillion yen (approximately US\$ 220 billion, as of June 2011), in terms of destroyed buildings and infrastructure. The indirect cost is estimated to be between 35 and 60 trillion yen (approximately US\$ 453 to 776 billion).³⁴ Figure 23 illustrates how direct and indirect risks affected the Japanese economy. This analysis begs the question of who will and should pay for such a historical catastrophe and what mechanisms need to be put in place to accelerate recovery time.

³⁴ Marsh Inc., estimation as of December 2, 2011, based on ongoing analysis of publicly available data to date.

Figure 23: Example of Business and Operational Risks and their Domino Effects



Source: Marsh Inc., 2011

Resiliency in Complex Systems May Come from Redundancy

When employees and customers of car manufacturers in Detroit saw news of the Japan tsunami, most would not have expected it to affect them personally. However, it soon became apparent that these manufacturers source parts from various companies, which in turn source microchip controllers from a company called Renesas. The plant where Renesas produces many of those chips, north of Tokyo, had been heavily damaged by the earthquake. With no alternative suppliers of automotive microcontroller chips, car production temporarily shut down.

This was hardly an unprecedented experience. The 1999 Taiwan Chi-Chi earthquake disrupted mobile phone manufacturers globally by interrupting the supply of semiconductors, while the 2007 Niigata-Chuetsu-Oki earthquake shut down automobile production across Japan by cutting off the supply of engine piston rings.³⁵ The danger is that such disruptions can be quickly forgotten as companies revert to the principles of lean business models, which imply that building redundancy and excess inventory into supply chains are a waste of resources.

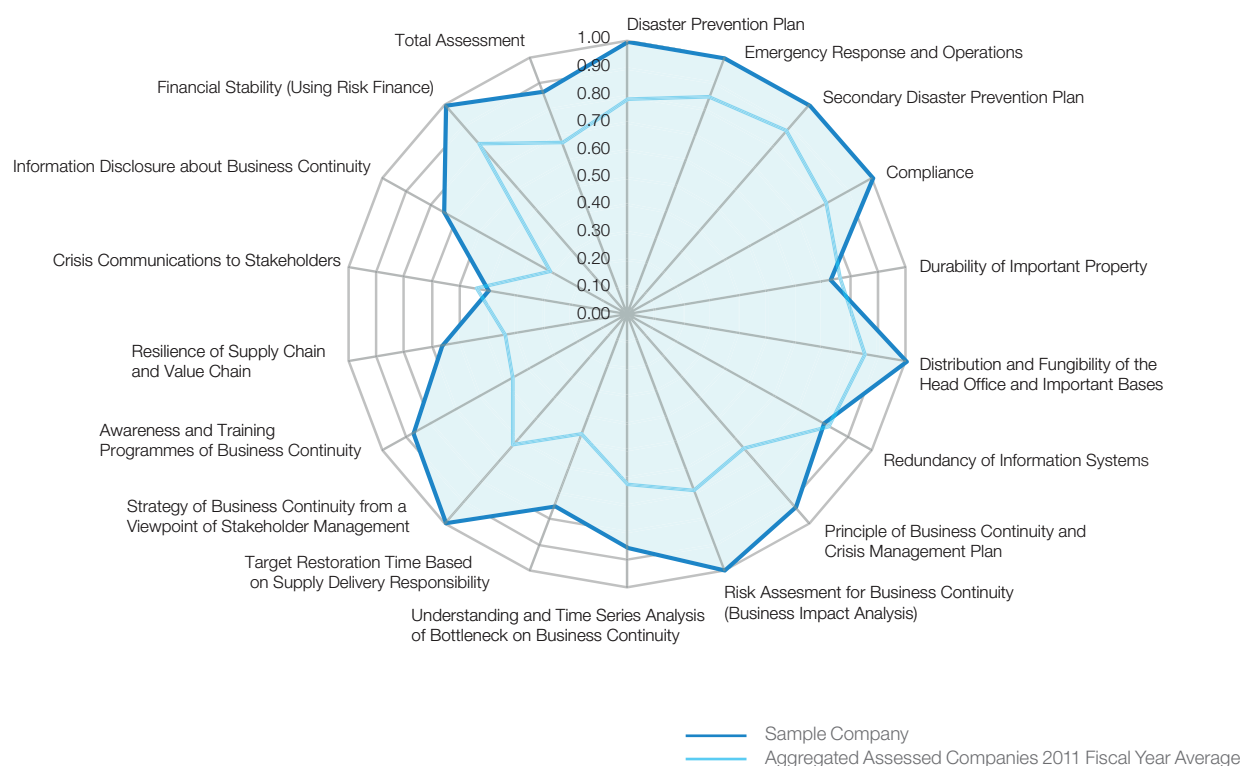
On the other hand, the Japanese Ministry of Land, Infrastructure and Transport's local liaison office has indicated that redundancy can provide resilience in a crisis. The office has the flexibility to mobilize trained personnel and necessary resources effectively and in a timely manner. Employees of the office, which had been restructured for greater efficiency, played a crucial role alongside US military, Japanese Self Defence Force and other external aid providers in accelerating the rescue effort by removing tsunami debris from an airport runway and allowing relief planes to land.

The Development Bank of Japan became the first in the world to offer more advantageous borrowing terms to companies that took steps to increase resilience in case of an emergency. This policy offers one indication that risk recognition may be improving. The bank screens 18 metrics on business continuity, preparedness and mitigation before deciding on loan premiums (see Figure 24).³⁶

³⁵ "2007 Niigata Chuetsu-Oki Japan Earthquake: Reconnaissance Report". Global Risk Miyamoto, <http://www.grmcat.com/images/Niigata-Chuetsu-Oki-Japan-Report.pdf>, 2007.

³⁶ Takeuchi, Y. and Hiruma, Y. "Analysis of post 3.11 risk management and how to design a resilient Japan - How should we manage tail risks". 2011, and *A Survey on the Disaster Preparedness and Business Continuity of Companies in the Great East Japan Earthquake*, September 2011. Japan: Development Bank of Japan Inc (DBJ).

Figure 24: Example of Organization Resilience Based on 18 Metrics



Source: Development Bank of Japan, 2011

The Value of Adaptive Leadership

While businesses across Japan suffered terrible losses in the aftermath of the tsunami, Lawson, a Japanese convenience store chain, coped better than most. Within four days, its production lines and logistics hub had recovered sufficiently to resume approximately 80% of its business.

Lawson stores continued to serve their communities, make vital supplies available and minimize financial losses to the company. This response has been attributed to the networked managerial structure put in place as a result of lessons learned from the 1995 Kobe earthquake disaster (see Figure 25). Each branch office was required to assess emerging risks and draft detailed disaster recovery plans twice a year; this will increase to three times a year in 2012. For example, bicycles were stationed in branch offices because they were the only functional means of transport in the 1995 earthquake. It became mandatory to keep stocks of emergency goods in branch offices, and the concentration of distribution hubs was reassessed to allow for more effective catering to disaster-struck evacuees. As the nature of crises can never be fully anticipated, a network of employees who have access to real-time coordinating mechanisms and the authority to make decisions can be more valuable than teams of highly-trained, specialized risk managers.³⁷

The value of distributed leadership in an organization was also demonstrated by the effective emergency response of the Joint Task Force Tohoku. It was the first time Japan's Self-Defence

Forces had ever operationally deployed a joint task force comprised of ground, air and maritime units. The Joint Task Force Tohoku is designed to operate with minimal central power, and its members anticipate dealing with a nuclear crisis on this scale "without a plan, strategy, training and intelligence".³⁸

Figure 25: Networked Organizations Fare Better in Sustained Crisis

Organization 1	Organization 2
Hierarchical	Networked
Centralized leadership	Distributed leadership
Tightly coupled (greater interdependence among parts)	Loosely coupled (less interdependence)
Concentrated workforce	Dispersed workforce
Specialists	Cross-trained-generalists
Policy and procedure driven	Guided by simple yet flexible rules

Source: Nohria, Nitin. "The Organization: Survival of the Adaptive". Harvard Business Review. <http://hbr.org/web/2009/pandemic/survival-of-adaptive>.

³⁷ Nohria, N. "The Organization: Survival of the Adaptive". Harvard Business Review, 2009. <http://hbr.org/web/2009/pandemic/survival-of-adaptive>.

³⁸ Funabashi, Y., and Takenaka, H. "The Catastrophe and Comprehensively-Linked Crisis;" Funabashi, Yoichi. "The Political Function: Post Mortem of a Crisis Governance". Forthcoming.

Such decentralized organizations have been likened to a starfish – able to regenerate severed limbs – in their greater capacity to be resilient and competitive in a complex and uncertain world.³⁹ In the starfish model of organization, leaders see one of their primary responsibilities as fostering a distributed capacity for leadership at all levels of their organization.⁴⁰ The starfish model depends on context, however. In a large-scale disaster, there are limitations to the capacity of local personnel to deal with the crisis, and there is a need for a central agency to have an overview of information and the power to direct responses.⁴¹

Advancing into the Information Space

As news channels around the world showed aerial shots of the Fukushima Daiichi nuclear plant spewing smoke, the people of Japan waited anxiously for an authoritative assessment of the current state of knowledge.

However, the Tokyo Electric Power Company (Tepco) had a reputation for being less than forthcoming in crisis situations, and as the hours passed without any such communication – neither to the prime minister's office nor to the public – rumours filled the gap. On the fourth day of the crisis, when the United States advised its citizens to evacuate to 80 kilometres away from the Fukushima plant (four times the zone imposed by the Japanese Government), many Japanese felt this confirmed their suspicion that the situation was more serious than their leaders were prepared to admit.

Criticism of the crisis response, in terms of communications, exemplifies the “tyranny of the time line”. As recently as a decade ago, the media typically expected institutions with responsibility in crises to issue statements within the first 24 hours, giving them leeway to gather information internally before responding publicly. With social media tools such as Twitter and the ubiquity of smart phones, information – and misinformation – can now propagate at breakneck speed and the window of opportunity for authorities to enter and dominate the information space has shrunk to a matter of minutes.⁴²

The reticence of Japanese leaders to disseminate information using digital media was understandable, as responding quickly carries inherent risks of being wrong, and they did not want to risk inciting panic and a chaotic exodus, especially from the Tokyo metropolitan area. However, the speculation that spread about the situation at Fukushima demonstrated how this reticence allowed rumours to take on the appearance of fact. This information gap made it more difficult for subsequent official explanations to displace rumours in the public consciousness.

Trust in the integrity of leaders is no longer best maintained by remaining silent until all the facts are collated. Instead, the better course of action is to clarify quickly and honestly what is known and what is not, in a language and context that can be easily understood by the audiences, such as legislators, citizens and advocacy groups. In addition, the March 2011 disaster further highlighted the need for authoritative, insightful and scientific evidence-based communication by trusted experts at varying

levels, starting at the top. For example, the UK Government Chief Scientific Adviser provided scientific advice to government during the 2009 swine flu outbreak and the 2010 volcanic ash incident, and it increased scientific capacity across Whitehall by encouraging all major departments of state to recruit a chief scientific adviser. While it is important to explain what has happened, the immediate focus of crisis communications must not be on apportioning blame but on what must be done to reduce harm and end the crisis.

The Skills of Leadership and Followership

The need for good leadership in a crisis situation is widely acknowledged. The response to the Great East Japan Earthquake also demonstrated the value of good “followership”.⁴³ This involves the capacity to avoid two extreme forms of group behaviour – excessive conformity and excessive conflict – that can impede the capacity for effective crisis response.⁴⁴

Both excessive conformity and excessive conflict manifested in the March 2011 disaster. Japan's traditional hierarchical structures exhibited excessive conformity, as they embodied the values of loyalty to the leader and preservation of unity. While this mind set is useful in routine work, it is less effective in crisis management, when uncomfortable truths may urgently need to be communicated.⁴⁵ Trust in the system had been undermined by six changes of leadership in the last five years, and rather than restoring this trust during the disaster response, Prime Minister Kan's newly established task forces blurred lines of communication from traditional hierarchical structures. Key personnel were overburdened with many meetings, and information from the ground did not always reach the Prime Minister's office in a clear and timely manner.⁴⁶ As one expert put it, there is a need to shift from the attitude of “see no evil, speak no evil, hear no evil” to “see well, speak frequently and listen attentively”.⁴⁷ The lesson is that multi-layer networks need to be created ahead of time to enable trusted sources from the public and private sector to filter information upwards quickly and effectively in times of crisis.

Emerging lessons from the Great East Japan Earthquake include: the importance of flexibility and resilience in response structures; the value of interoperability, as military cooperation made it easier to work jointly in the relief work; the benefits of systemic resilience that consider multiple hazards; the need to distribute responsibility across society rather than leaving it only with the public sector; and the value of understanding how man-made systems can amplify or minimize the risks of natural disasters.

⁴³ Funabashi, Y., and Takenaka, H. “The Catastrophe and Comprehensively-Linked Crisis;” Funabashi, Yoichi. “The Political Function: Post Mortem of a Crisis Governance”. Forthcoming.

⁴⁴ Boin, A. *The Politics of Crisis Management: Public Leadership Under Pressure*. Cambridge: Cambridge University Press, 2006.

⁴⁵ Funabashi, Y., and Takenaka, H. “The Catastrophe and Comprehensively-Linked Crisis;” Funabashi, Yoichi. “The Political Function: Post Mortem of a Crisis Governance”. Forthcoming.

⁴⁶ Ibid.

⁴⁷ Takeuchi, Y. and Hiruma, Y. “Analysis of post 3.11 risk management and how to design a resilient Japan - How should we manage tail risks”. 2011, and *A Survey on the Disaster Preparedness and Business Continuity of Companies in the Great East Japan Earthquake*, September 2011. Japan: Development Bank of Japan Inc (DBJ).

³⁹ Braffman, O., and Beckstrom, R. *The Starfish and the Spider*. New York: Penguin Group, 2007.

⁴⁰ Nonaka, I. and Takeuchi, H. “The Big Idea: The Wise Leader”. *Harvard Business Review*, May 2011. <http://hbr.org/2011/05/the-big-idea-the-wise-leader/ar/1>.

⁴¹ Funabashi, Y., and Takenaka, H. “The Catastrophe and Comprehensively-Linked Crisis;” Funabashi, Yoichi. “The Political Function: Post Mortem of a Crisis Governance”. Forthcoming.

⁴² Gowing, N. “‘Skyful of Lies’ and Black Swans: the New Tyranny of Shifting Information Power in

Questions for Stakeholders

- How can resilience, flexibility and interoperability be built into disaster response structures?
- How can systemic resilience best be fostered by considering multiple hazards, especially in times of austerity?
- How can responsibility in times of crisis be shared more fully by the private sector and society, rather than leaving it primarily with the public sector?
- How can man-made systems be built to minimize rather than amplify the risks of natural disasters?
- How can the right skills and leadership be nurtured to be more readily adapted to an evolving crisis situation?

The Risk Categories

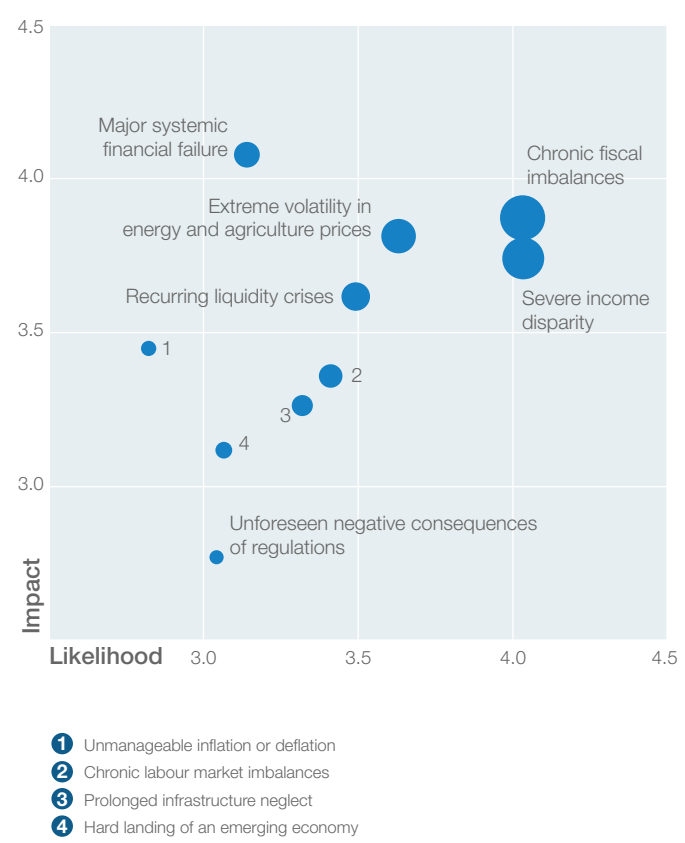
The 50 global risks in this report are divided into five categories: economic, environmental, geopolitical, societal and technological.

● Economic

The economic category addresses those risks that are of greatest concern in terms of likelihood and impact in areas covering a range of macroeconomic concerns, from financial systems and infrastructure to price volatility and regulation (see Figure 28 for the full list of economic risks). Being in the forefront of public debate in recent years, **chronic fiscal imbalances** and **severe income disparity** emerged this year as the two most likely economic risks to manifest in the coming 10 years. In addition, these two risks are rated as having potentially high impact, along with **extreme energy** and **agriculture price volatility**, as well as **major systemic financial failure** (see Figure 26).

Responses to this year’s survey identified **chronic fiscal imbalances** as the Centre of Gravity in the economic category (see Figure 27). Chronic fiscal imbalances shares important interconnections with risks from three categories, and it is most strongly associated with the economic risk of major systemic financial failure – a risk that captures the collapse of both major finance and banking institutions, as well as currency regimes. As the Centre of Gravity in the economic category, it follows that the topic of chronic fiscal imbalances is linked to all four Critical Connectors. It is also strongly associated with **global governance failure**, **mismanagement of population ageing** and several geopolitical and societal risks, which relate to the collapse of governments and international trade. Interestingly, all four Critical Connectors are economic in nature, which demonstrates that economic risks play a particularly significant role in defining the level of resilience or instability within the global risk system as a whole.

Figure 26: Economic Risks



Source: World Economic Forum

Figure 27: Chronic Fiscal Imbalances is the Centre of Gravity in the Economic Category



Source: World Economic Forum

Figure 28: Economic Risk Descriptions

Chronic fiscal imbalances	Failure to redress excessive government debt obligations.
Chronic labour market imbalances	A sustained high level of unemployment that is structural rather than cyclical in nature, coinciding with a rising skills gap and high underemployment, especially among youth populations.
Extreme volatility in energy and agriculture prices	Severe price fluctuations make critical commodities unaffordable, slow growth, provoke public protest and increase geopolitical tension.
Hard landing of an emerging economy	The abrupt slowdown of a critical emerging economy.
Major systemic financial failure	A financial institution or currency regime of systemic importance collapses with implications throughout the global financial system.
Prolonged infrastructure neglect	Chronic failure to adequately invest in, upgrade and secure infrastructure networks.
Recurring liquidity crises	Recurring shortages of financial resources from banks and capital markets.
Severe income disparity	Widening gaps between the richest and poorest citizens.
Unforeseen negative consequences of regulation	Regulations which do not achieve the desired effect, and instead negatively impact industry structures, capital flows and market competition.
Unmanageable inflation or deflation	Failure to redress extreme rise or fall in the value of money relative to prices and wages.

Source: World Economic Forum

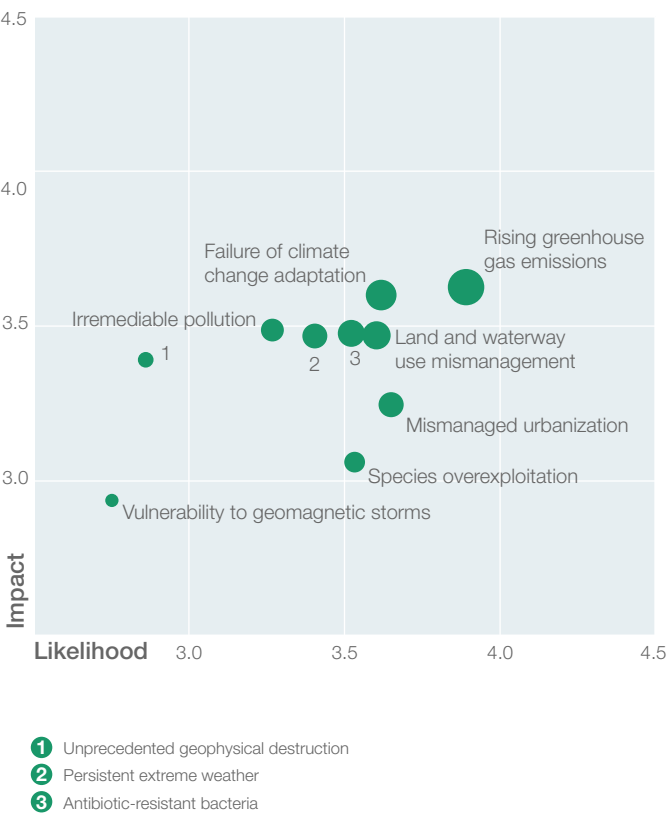
● Environmental

The environmental category addresses environmental global risks of high concern, from natural disasters such as extreme weather and geomagnetic storms, to man-made disasters such as irremediable pollution and species overexploitation. If realized, these risks have the potential to destabilize both economies and societies, trigger geopolitical conflict and devastate the Earth’s vital resources and its inhabitants (see Figure 31 for the full list of environmental risks).

The two key pillars of climate change – continued rising greenhouse gas emissions and the failure of climate change adaptation – top this category with the highest impact. Interestingly, survey respondents collectively rated man-made risks, such as mismanaged urbanization, land and waterway use mismanagement and species overexploitation, as more likely to occur in the next 10 years than natural disasters such as earthquakes and volcanic eruptions (unprecedented geophysical destruction), persistent extreme weather and geomagnetic storms.

The 2012 Global Risks Survey identified rising greenhouse gas emissions as the Centre of Gravity in the environmental category. Failure of climate change adaptation is the most strongly associated risk in this category and could rival rising greenhouse gas emissions as a Centre of Gravity (see Appendix 2). The environmental Centre of Gravity shares direct connections to several risks in its own category and particularly to economic and societal risk categories, while the only geopolitical connection is the geopolitical Centre of Gravity – global governance failure. In addition, the risk of rising greenhouse gas emissions is highly connected to two Critical Connectors: unforeseen negative consequences of regulation and extreme volatility in energy and agriculture prices. These connections highlight the systemic significance of rising greenhouse gas emissions through both its direct and indirect associations.

Figure 29: Environmental Risks



Source: World Economic Forum

Figure 30: Rising Greenhouse Gas Emissions is the Centre of Gravity in the Environmental Category



Source: World Economic Forum

Figure 31: Environmental Risk Descriptions

Antibiotic-resistant bacteria	Growing resistance of deadly bacteria to known antibiotics.
Failure of climate change adaptation	Governments and business fail to enforce or enact effective measures to protect populations and transition businesses impacted by climate change.
Irremediable pollution	Air, water or land permanently contaminated to a degree that threatens ecosystems, social stability, health outcomes and economic development.
Land and waterway use mismanagement	Deforestation, waterway diversion, mineral extraction and other environment modifying projects with devastating impacts on ecosystems and associated industries.
Mismanaged urbanization	Poorly planned cities, urban sprawl and associated infrastructure that amplify drivers of environmental degradation and cope ineffectively with rural exodus.
Persistent extreme weather	Increasing damage linked to greater concentration of property in risk zones, urbanization or increased frequency of extreme weather events.
Rising greenhouse gas emissions	Governments, businesses and consumers fail to reduce greenhouse gas emissions and expand carbon sinks.
Species overexploitation	Threat of irreversible biodiversity loss through species extinction or ecosystem collapse.
Unprecedented geophysical destruction	Geophysical disasters such as earthquakes and volcanic activity of unparalleled magnitude or unforeseen frequency that overwhelm existing precautions.
Vulnerability to geomagnetic storms	Critical communication and navigation systems disabled by effects from colossal solar flares.

Source: World Economic Forum

● Geopolitical

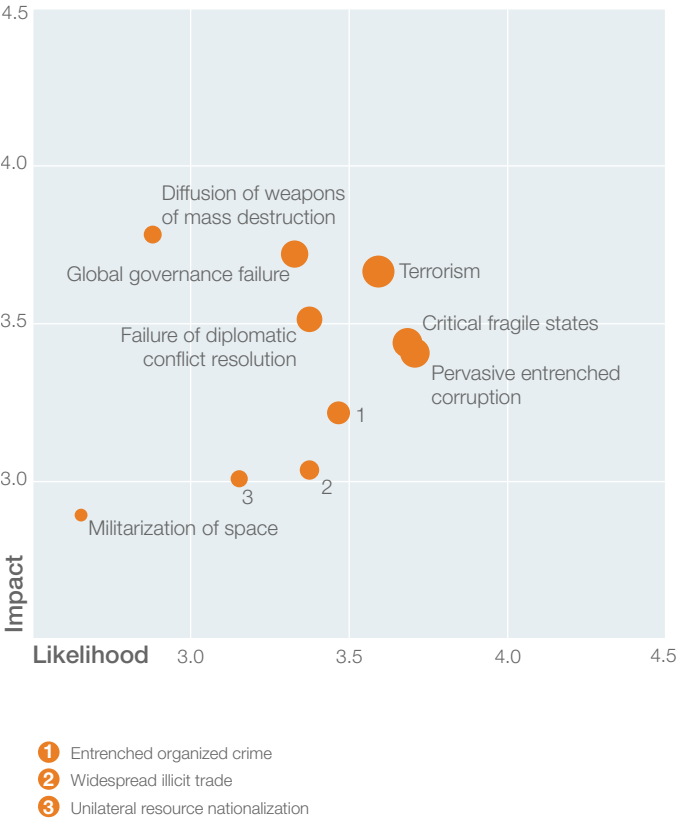
The geopolitical category addresses risks that are of greatest concern in the areas of politics, diplomacy, conflict, crime and governance on a global scale. From **diffusion of weapons of mass destruction** to **pervasive entrenched corruption**, geopolitical risks are global risks of humanity’s own making. The threats of geopolitical risks range from undermining socioeconomic progress to annihilating society and earth’s resources (see Figure 34 for the full list of geopolitical risks).

Global governance failure was ranked second in the highest impact along with **diffusion of weapons of mass destruction**, but the former is regarded as relatively more likely to occur in the next 10 years. Pervasive entrenched corruption, critical fragile states, terrorism, entrenched organized crime, failure of diplomatic conflict resolution and widespread illicit trade were all rated a higher likelihood than global governance failure; however, their perceived impacts are lower. Most of these risks clustered around a likelihood of 3.5 (Figure 32). Militarization of space, similar to other space- and frontier-science related risks in the technological category, appears to be a relatively low concern of survey respondents looking ahead to the next 10 years.

Responses to this year’s survey identified **global governance failure** as the Centre of Gravity in the geopolitical category. Global governance failure is the most interconnected of the 50 global risks – it has a direct connection with 75% of the risks covered in this report. This Centre of Gravity also shares important interconnections with risks from all five categories, all four Critical Connectors, as well as the Centres of Gravity in the economic, environmental, societal and technological categories.

Compared to the other four Centres of Gravity, global governance failure shares the highest number of very strong interconnections, measured by the frequency with which survey respondents selected that pairing of risks as systemically very important. This underlines the weight of this Centre of Gravity’s influence over the entire system, which is why it is centrally positioned in this year’s Global Risks Map (Figure 3).

Figure 32: Geopolitical Risks



Source: World Economic Forum

Figure 33: Global Governance Failure is the Centre of Gravity in the Geopolitical Category



Source: World Economic Forum

Figure 34: Geopolitical Risk Descriptions

Critical fragile states	A weak state of high economic and geopolitical importance that faces strong likelihood of collapse.
Diffusion of weapons of mass destruction	The availability of nuclear, chemical, biological and radiological technologies and materials leads to crises.
Entrenched organized crime	Highly organized, disciplined and deep-rooted global networks, committing criminal offences.
Failure of diplomatic conflict resolution	The escalation of international disputes into armed conflicts.
Global governance failure	Weak or inadequate global institutions, agreements or networks, combined with competing national and political interests, impede attempts to cooperate on addressing global risks.
Militarization of space	Targeting of commercial, civil and military space assets and related ground systems as core to defence strategy.
Pervasive entrenched corruption	The widespread and deep-rooted abuse of entrusted power for private gain.
Terrorism	Individuals or a non-state group successfully inflict large-scale human or material damage.
Unilateral resource nationalization	Unilateral moves by states to ban exports of key commodities, stockpile reserves and expropriate natural resources.
Widespread illicit trade	Unchecked spread of illegal trafficking of goods and people throughout the global economy.

Source: World Economic Forum

● Societal

The societal category addresses trends and uncertainties in population dynamics, social stability and human survival. Global risks in this category put into question the stability of modern civilization and the continued well-being of populations (see Figure 37 for the full list of societal risks).

Figure 35 shows that from food and water shortage crises to rising religious fanaticism, societal risks all have a relatively high likelihood of occurring in the next 10 years. Water supply crisis has the highest impact and highest likelihood, with food shortage crisis following closely behind. The other seven risks in the societal category, as well as the Centre of Gravity, cluster around an impact and likelihood of 3 to 3.5, indicating that concerns for these risks are equally high and that there is potential for far-reaching impact of all of these risks on societies, communities and individuals.

Responses to the Global Risks Survey identified unsustainable population growth as the Centre of Gravity in the societal category. Unsustainable population growth shares important interconnections with risks from all categories, with the exception of technological risks. While the societal Centre of Gravity clusters together with the majority of societal risks in likelihood and potential impact, it is most strongly associated with food shortage crises. Along with water shortage, they both stand out from other societal risks as having a relatively high likelihood and potential impact in the next 10 years. Strongly connected to mismanaged urbanization and severe income disparity, unsustainable population growth also shares important direct connections to three Critical Connectors, as well as the Centres of Gravity in the economic, environmental and geopolitical categories. This positioning underscores its systemic importance.

Figure 35: Societal Risks



Source: World Economic Forum

Figure 36: Unsustainable Population Growth is the Centre of Gravity in the Societal Category



Source: World Economic Forum

Figure 37: Societal Risk Descriptions

Backlash against globalization	Resistance to further increased cross-border mobility of labour, goods and capital.
Food shortage crises	Inadequate or unreliable access to appropriate quantities and quality of food and nutrition.
Ineffective drug policies	Continued support for policies that do not abate illegal drug use but do embolden criminal organizations, stigmatize drug users and exhaust public resources.
Mismanagement of population aging	Failure to address both the rising costs and social challenges associated with population aging.
Rising rates of chronic disease	Increasing burden of illness and long-term costs of treatment threaten recent societal gains in life expectancy and quality.
Rising religious fanaticism	Uncompromising sectarian views that polarize societies and exacerbate regional tensions.
Unmanaged migration	Mass migration driven by resource scarcity, environmental degradation and lack of opportunity, security or social stability.
Unsustainable population growth	Population size and its rate of growth create intense and rising pressure on resources, public institutions and social stability.
Vulnerability to pandemics	Inadequate disease surveillance systems, failed international coordination and the lack of vaccine production capacity.
Water supply crises	Decline in the quality and quantity of fresh water combine with increased competition among resource-intensive systems, such as food and energy production.

Source: World Economic Forum

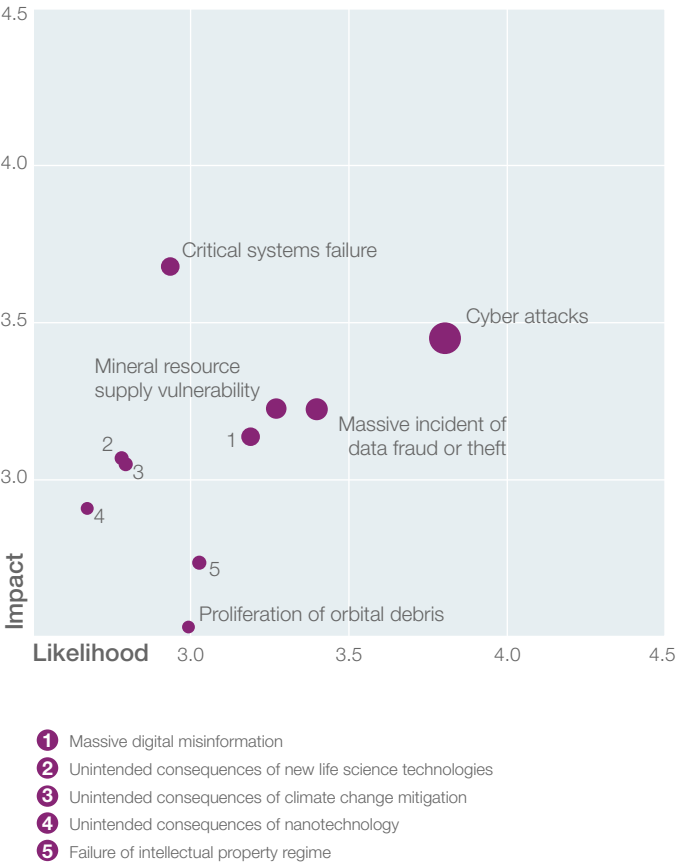
● Technological

The technological category addresses risks that are of greatest concern in the area of current and emerging technology. Figure 38 shows a landscape of global technological risks as plotted by their perceived likelihood and potential impact over the next 10 years. Within the technology category, volatility and the inability to “know the unknowns” are revealed by the large spread of impacts and likelihood of the risks. Technological risks range from **cyber attacks**, highlighted as having the highest likelihood and a high impact, to **critical systems failure** having the highest impact and lower likelihood, and to the **unintended consequences of nanotechnology**, which has a lower impact and lower likelihood (see Figure 40 for the full list of technological risks).

Of the 10 technological risks, **critical systems failure** was singled out as the one risk that has the most important influence and consequence and therefore, as the technological Centre of Gravity. Critical systems failure shares important interconnections with risks from all five categories. It is most strongly associated with **cyber attacks** and three economic risks: **prolonged infrastructure neglect**, **unforeseen negative consequences of regulation** and **major systemic financial failure**.

The technological Centre of Gravity was identified as a key concern for world leaders from government, business and civil society. It was assessed by survey respondents as a relatively low likelihood, but potentially high impact risk – a combination typical of events that catch humanity off guard. Crucially, **critical systems failure** shares important direct connections to all four Critical Connectors, as well as the Centres of Gravity in the economic, environmental and geopolitical categories. These linkages underline its position of great systemic importance (see Figure 39).

Figure 38: Technological Risks



Source: World Economic Forum

Figure 39: Critical Systems Failure is the Centre of Gravity in the Technological Category



Source: World Economic Forum

Figure 40: Technological Risk Descriptions

Critical systems failure	Single-point system vulnerabilities trigger cascading failure of critical information infrastructure and networks.
Cyber attacks	State-sponsored, state-affiliated, criminal or terrorist cyber attacks.
Failure of intellectual property regime	Ineffective intellectual property protections undermine research and development, innovation and investment.
Massive digital misinformation	Deliberately provocative, misleading or incomplete information disseminates rapidly and extensively with dangerous consequences.
Massive incident of data fraud/theft	Criminal or wrongful exploitation of private data on an unprecedented scale.
Mineral resource supply vulnerability	Growing dependence of industries on minerals that are not widely sourced with long extraction-to-market time lag for new sources.
Proliferation of orbital debris	Rapidly accumulating debris in high-traffic geocentric orbits jeopardizes critical satellite infrastructure.
Unintended consequences of climate change mitigation	Attempts at geoengineering or renewable energy development result in new complex challenges.
Unintended consequences of nanotechnology	The manipulation of matter on an atomic and molecular level raises concerns on nanomaterial toxicity.
Unintended consequences of new life science technologies	Advances in genetics and synthetic biology produce unintended consequences, mishaps or are used as weapons.

Source: World Economic Forum

Box 5: X Factors

In a world of unknown unknowns and known unknowns, we are constantly on the search to identify X factors – emerging concerns of possible future importance and with unknown consequences. Although they are not considered among the global risks surveyed, they were submitted by experts as issues to monitor in the future. In this year's survey, a blank field was introduced in which respondents could suggest risk concepts that are not covered in the set of 50, but which they felt should be. Similar exercises in out-of-the-box thinking have been carried out in workshops and expert interviews. Below are some examples of note from this year's report.

Constant connectivity – Connectivity enabled by the Internet could be changing our cognition in ways that are less suitable to deal with complexity, uncertainty and sustainability.

Epigenetics – This emerging field studies inherited traits in humans and other species derived from changes in the expression of genetic code, rather than from changes to the genetic code itself. New theories suggest that products and experiences can impact human genetics in a previously unexpected way, which can generate unforeseen risks.

Financial illiteracy – This gap results in a lack of sufficient understanding of finance, financial systems and services to a) effectively regulate and monitor financial systems, b) sustainably manage the finances of government and business, and c) effectively manage personal finances to provide security and stability in old age when state pension systems fail to provide.

Mega-accidents – The accidental oil and chemical spills of the future will be spills of genetically modified micro-organisms and nano-scale materials, which overwhelm outmoded response capacities with potentially devastating environmental and human impacts.

Mis-education – Skills gaps and inequalities widen as people continue to be educated for 20th century economies and labour qualifications.

Mis-information – The gatekeepers of the broadcast news era are gone, and the integrity and ethics of mass reporting online are increasingly unknown.

Neotribalism – Polarized subcultures in the physical world create borderless communities through the virtual space that can affect political regimes in the real world.

Resource wars – Scarce natural resources, from oil to potable water, could prompt violent conflict.

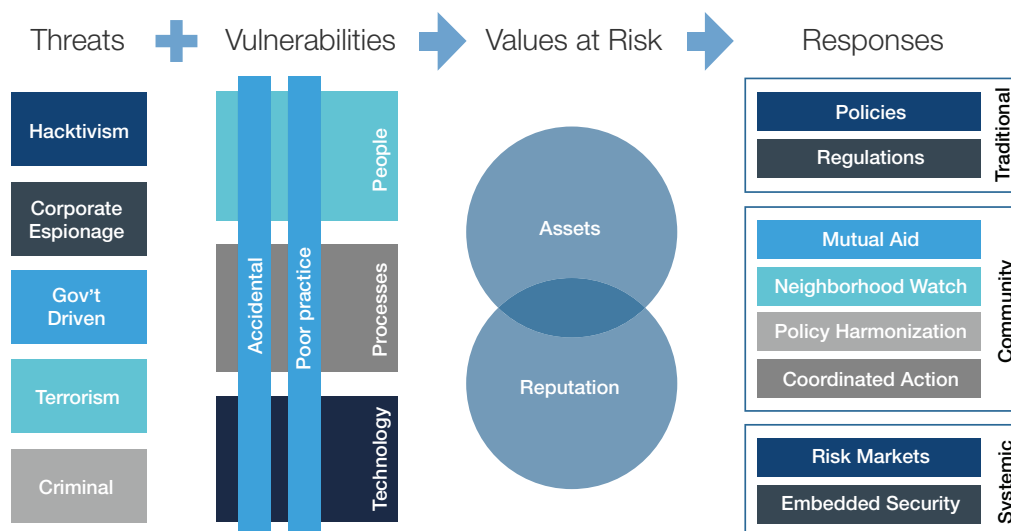
Volcanic winter – A level 7 or 8 eruption on the Volcanic Explosivity Index, which alters the Earth's atmospheric composition, could cool the planet and, at the least, ruin several seasons of food production. At worst, it could present an existential threat to modern civilization.

Risks in Depth: Risk and Responsibility in a Hyperconnected World Project

Throughout 2011, the Forum's Information Technology Industry Partnerships and the Risk Response Network sponsored a multistakeholder project to identify and address emerging global systemic risks that arise from the increasing connectivity of people, processes and objects. Cyber security emerged as the key risk, and it encompasses a wide range of complex issues, ranging from behavioural to geopolitical in nature (see Figure 41).

This is further explored in the case on the Dark Side of Connectivity in this report. Cyber security is not a problem that any one organization, private or public, can solve alone, as many aspects can be analysed in economic terms as negative externalities, coordination failures or instances of game theory's Prisoner's Dilemma.

Figure 41: Framework for Cyber Threats and Responses



Source: World Economic Forum

Initial insights highlighted that cyber security solutions exist, but human behaviour is frequently a key weakness: while best practices are led at the executive level, an understanding of the risk lies at the board level. Providing executives with information and tools to understand and mitigate the vulnerabilities within their organizations presented itself as one way to create immediate impact.

In addition to improving the resilience of organizations, good “cyber hygiene” simultaneously contributes to the security of the overall environment. To reduce the overall levels of residual risk in the global value chain, a critical mass needs to be achieved. As with immunizing a population, 100% coverage is not required, but immunization levels must be sufficient to isolate outbreaks and disrupt the spread of disease. The Risk and Responsibility in a Hyperconnected World project is developing tactics to move toward this critical mass.

For additional information, see <http://www.weforum.org/content/pages/risk-and-responsibility-hyperconnected-world>.

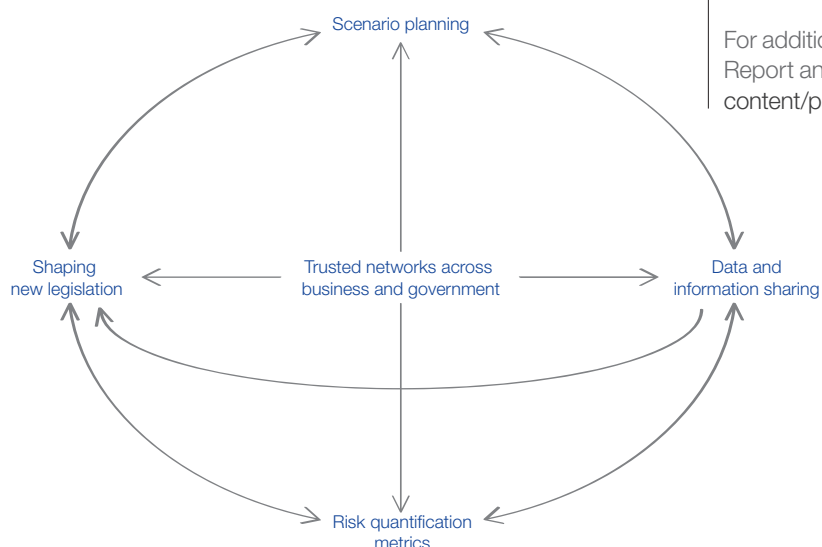
Risks in Depth: Supply Chain and Transport Initiative

New Models for Addressing Supply Chain and Transport Risk

Over the last few decades many companies have sought to optimize their supply chains by creating lean production and distribution systems. These complex systems form the backbone of trade and the global economy. While improvements to these systems have generally increased efficiency, the growing complexity and interdependence of these systems means that the cascading consequences of major systemic disruptions can be increasingly unpredictable and difficult to manage.

Recent examples of global disruptions that have tested the robustness of supply chain and transport systems – and tolerance of uncertainty by organizations – include the 2010 Icelandic volcano, the 2011 Great East Japan Earthquake and the massive floods in Thailand. Meanwhile, regional risks such as piracy in the Gulf of Aden have gained global attention for their security implications.

Figure 42: Networks of Mitigation Strategies



Source: World Economic Forum

Organizations are constantly assessing their own supply chains and transport networks, as well as their capability to respond quickly to unexpected disruptions. Most of these are managed at the local level; however, the nature of global systemic disruptions means there are limits to any one organization's ability to fully address vulnerabilities on its own. Better multistakeholder models are required to plan for contingencies and build greater systemic resilience that will insulate against shocks to the system, no matter where they originate.

In particular, public-private engagement in collaborative risk assessment, as well as greater sharing of data around threats and vulnerabilities, could move the public policy conversation from prescriptive regulatory approaches to a more focused collaboration on solving for emerging threats and vulnerabilities. As discussed in Case 2 – How Safe are our Safeguards? (page 20) – the concept of “anticipatory governance” could be applied to challenges in regulating global supply chains. This approach could avoid repeating some of the unmanageable post-9/11 prescriptive responses, such as 100% cargo inspection regimes.

In 2011, the World Economic Forum conducted multiple interviews and surveyed a representative group of supply chain and transport risk experts to identify the most significant global disruptions to supply chain and transport networks. Disruptions included natural disasters, conflict, political unrest and terrorism, along with the most important global operational vulnerabilities that hinder response and resilience.

By assessing the expert group's views on the mitigation strategies most likely to be effective in the future and most in need of development, five priority mitigation areas were identified: developing expert networks across business and government; defining and measuring risk quantification to support effective decision making; implementing effective legislation and incentives; improving data and information sharing; and extending uses of scenario planning (Figure 42).

Regional multistakeholder task forces could take collaborative action regarding regional differences in risk exposure, economic mix and regulation requirements. Such coordination could improve the compatibility of risk management efforts, improve sharing of response plans and intelligence, strengthen risk measurement and understanding, and facilitate the development of mechanisms to allow the movement of people and goods during a disruption – particularly those most critically needed by society.

For additional information, see the Supply Chain and Transport Risk Report and accompanying website: <http://www.weforum.org/content/pages/supply-chain-and-transport-risk-initiative>.

Further Action

The increasingly global environment makes it more important than ever for leaders and experts to put into place the fundamentals underpinning growth and development. The *Global Risks 2012* report contributes to this process by bringing to attention and analysing the most current risks that leaders and experts believe are of highest concern now and for the next 10 years.

By offering policy-makers, business executives, academics and the public insights into the complexity and interconnections that underpin global risks today, the report raises awareness regarding areas that call for immediate action to ensure robust development and long-term wellbeing. It captures the perceptions of leading academics and a global network of Partner Institutes through surveys, workshops and interviews.

This report sheds light on specific areas of concern or interest that could become future in-depth projects for investigation and analysis by the Risk Response Network with an interested organization.

The Risk Response Network

The Risk Response Network was launched at the Annual Meeting in Davos in January 2011 to bring together private and public sector partners around risk issues of common concern, with the common goal of monitoring, mitigating, managing and measuring global risks. It is comprised of senior risk officers and leading experts on economic, geopolitical, environmental, societal and technological risks from:

- Governments, international organizations and NGOs
- Multinational corporations from all industrial sectors
- Leading academic and research institutions

Further Steps

Data from World Economic Forum surveys, workshops, interviews and information provided by Forum Members make up a very important part of the *Global Risks 2012* report. To ensure that this report continues to address the world's risks, sharing of relevant data and information is of great importance. This includes sharing tools that create a robust platform from which the Risk Response Network, Forum Members and the world can manage and mitigate risks.

Future surveys, workshops and interviews will be conducted to feed into the in-depth projects and *Global Risks 2013* report. The Risk Response Network is also undertaking research and development on dynamic barometers that can gauge factors contributing to important global risks.

“What If” Scenarios

The Risk Response Network also regularly conducts interviews with experts to uncover the risks appearing in their peripheral vision. These “What If” scenarios explore complex contingencies that could emerge outside the identified global risk landscape, as well as unexpected variations of identified global risks. To read a sample of interviews, visit <http://www.weforum.org/WhatIf>.

Further Information

Please refer to www.weforum.org/globalrisks2012 for more information online.

Conclusion

Over the past seven years this report has developed a methodology to improve the analysis of interconnected global risks – those which no single country, region, sector or industry is likely to be able to confront or prevent on their own.

The risk clusters highlighted in previous analyses – such as the water-food-energy nexus and the global illicit economy – will not disappear, but with each new year, risk perceptions can vary. In 2012, concern about the growth prospects of the world economy is at the forefront of respondents' concerns, and this subject pervades all three distinct, yet interconnected, cases presented in this report. Two risks that feature prominently in this year's report – cybersecurity and demographic challenges – also emerged in *Global Risks 2011* as risks to watch, while the governance of complex systems has been an underlying theme of previous reports.

Three common, crosscutting observations emerged from the varied groups of experts consulted to construct the three cases:

- Decision-makers need to improve understanding of incentives that will improve collaboration in response to global risks
- Trust, or lack of trust, is perceived to be a crucial factor in how risks may manifest themselves. In particular, this refers to confidence, or lack thereof, in leaders, in the systems which ensure public safety and in the tools of communication that are revolutionizing how we share and digest information
- Communication and information sharing on risks must be improved by introducing greater transparency about uncertainty and conveying it to the public in a meaningful way

The goal of this report is to inform and alert decision-makers on risk perceptions and emerging cases, as well as to illustrate – as in the Special Report on Japan – the compounding and unpredictable effects of risks in complex systems.

The work of the World Economic Forum's Risk Response Network throughout 2012 will be based on this report. The Forum is also exploring the development of a real-time risk barometer as a dynamic tool to track shifting perceptions of likelihood and impact of global risks.

More information on these initiatives and other World Economic Forum activities on global risks can be found at www.weforum.org/globalrisks2012.

Appendices

Appendix 1 - The Global Risks Survey

The annual Global Risks Survey collates the views of the World Economic Forum's multistakeholder network of the world's leading experts on global risks.

The 2012 Survey Questions

Question 1 – Risk likelihood in the next 10 years: “In your opinion, how likely is each of the following global risks to occur over the next 10 years?” Survey respondents were asked to rate each of the 50 risks on a scale from 1 (very unlikely) to 5 (almost certain).

Question 2 – Risk impact in the next 10 years: “If they were to occur in the next 10 years, please provide your best estimate of the total global impact that each of these risks would have.” (Impact is to be interpreted in a broad sense, beyond just economic consequences). Survey respondents were asked to rate each of the 50 risks on a scale from 1 (low) to 5 (high).

Question 3 – Systemic risks: “Intuitively select a Centre of Gravity – the most systemically important risk – for each category. Also indicate, for each of these, what you feel the most important global risk interconnection would be.”

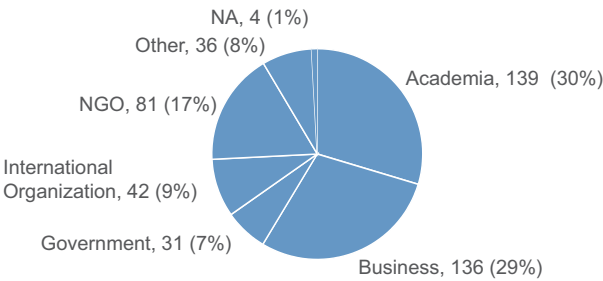
Question 4 – Respondent information (voluntary): Respondents were asked about their country of residence, the type of organization they work for and their area of expertise.

Sample Description

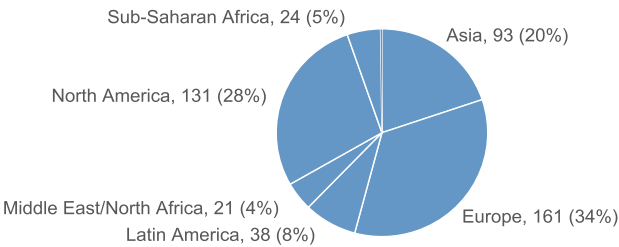
The survey sample of 469 respondents encompasses a diverse group of experts with the following backgrounds in Figure 43.

Figure 43: Breakdown of Survey Sample

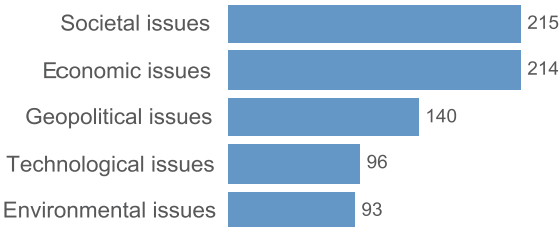
Type of Organization



Region of Residence



Expertise



NB: Multiple selections were possible for the question on expertise

Source: World Economic Forum

Appendix 2 – In-depth Survey Results

Variation

The primary statistics that were used in the report are the average (mean) values of the likelihood and impact scores of each of the 50 global risks, as depicted in the risk landscape of Figure 2, where they are used as the x- and y-coordinates for individual dots.

In addition to these averages, it is also instructive to look at the variation of individual survey responses. Figure 44 depicts these in the form of individual scatter plots – one for each risk – with likelihood on the horizontal, and impact on the vertical axis. The saturation of the colours of the “tiles” indicates how many people have chosen that particular x-y combination. The darker the colour, the more votes it received. In essence, the graph represents a two-variable histogram, depicted from above.

The figure shows the wide distribution of responses over the scatter plots; there are very few empty tiles. Those that have not been chosen tend to be in the low-high and high-low regions. Generally,

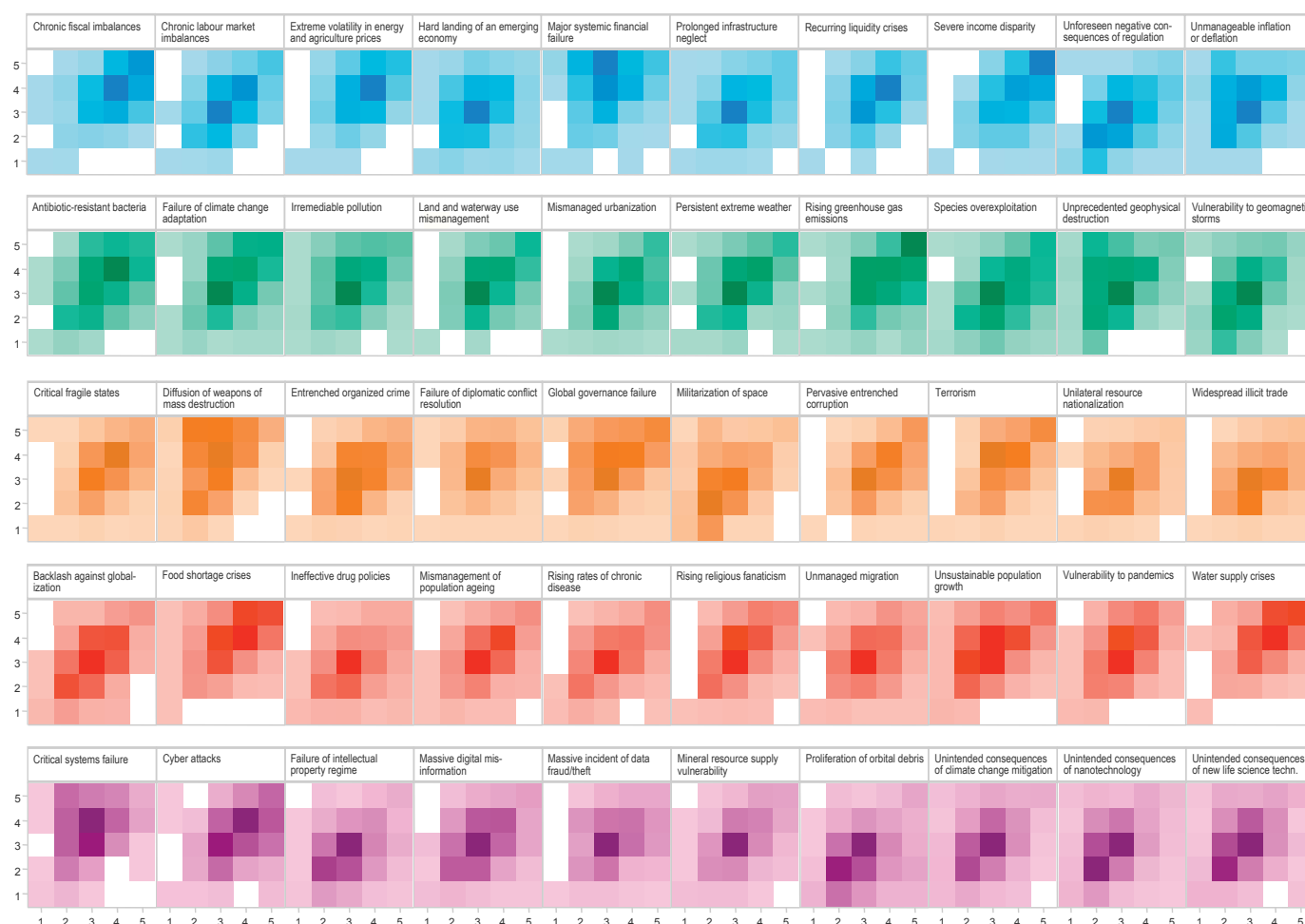
answers tend to cluster loosely along the diagonal connecting the other two points: low impact-low likelihood and high impact-high likelihood. Indeed, if responses for all risks are taken together, there is a slight positive correlation between the two variables (with a correlation coefficient of 0.39). One potential explanation is that people generally worry more about an individual risk, without fully disentangling its likelihood and impact.

Further, the modal tiles (the most common choices) are often – but not always – located near the centre of the scatter plot. It is well known that people tend to choose values in the middle of a range when asked to rate a certain issue, unless they feel very strongly about it.⁴⁸ The so-called central-tendency bias offers a potential explanation for this observation. However, for many risks, the mean likelihood and impact scores fall above that central point (as shown in the Global Risks Landscape 2012), which indicates that the distributions display a negative skew.

To investigate this phenomenon, individual responses were screened for instances where people chose similar values for all risks, and only two such instances could be classified as such. Thus, on the whole, the survey results are not heavily affected by central-tendency bias.

Figure 44: Distribution of Survey Responses

These graphics are two-variable histograms, showing impact and likelihood. The darker the colour, the higher the concentration of votes.



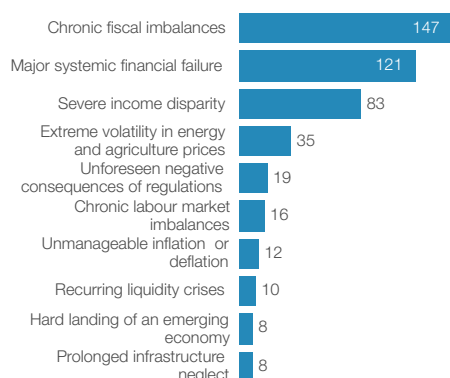
Source: World Economic Forum

⁴⁸ Baumgartner H, Steenkamp J-BEM. "Response Styles in Marketing Research: A Cross-National Investigation". *Journal of Marketing Research*, 2001, 38: 143-156.

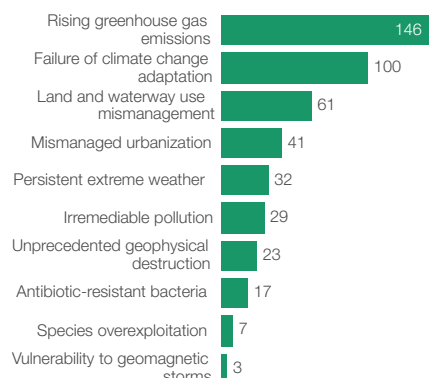
Just as there was variation around the likelihood and impact scores, the responses to the question about the Centres of Gravity also varied considerably. Figure 45 shows the frequency with which the risks were chosen as Centres of Gravity. Within each of the five categories, a single risk is clearly distinguished, and this factor represents a Centre of Gravity throughout this report.

Figure 45: Survey Responses to the Question on Centres of Gravity

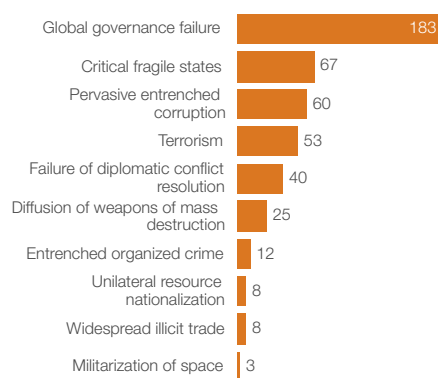
Economic Risks



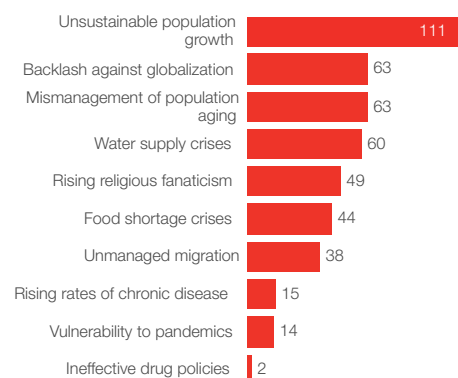
Environmental Risks



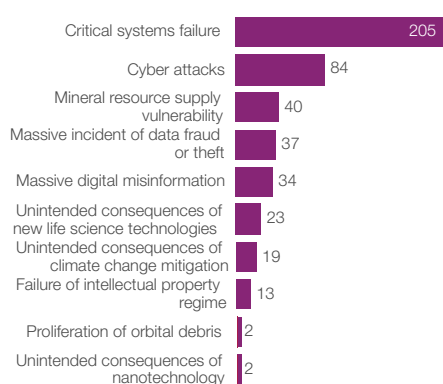
Geopolitical Risks



Societal Risks



Technological Risks



Source: World Economic Forum

Differences between Sub-groups

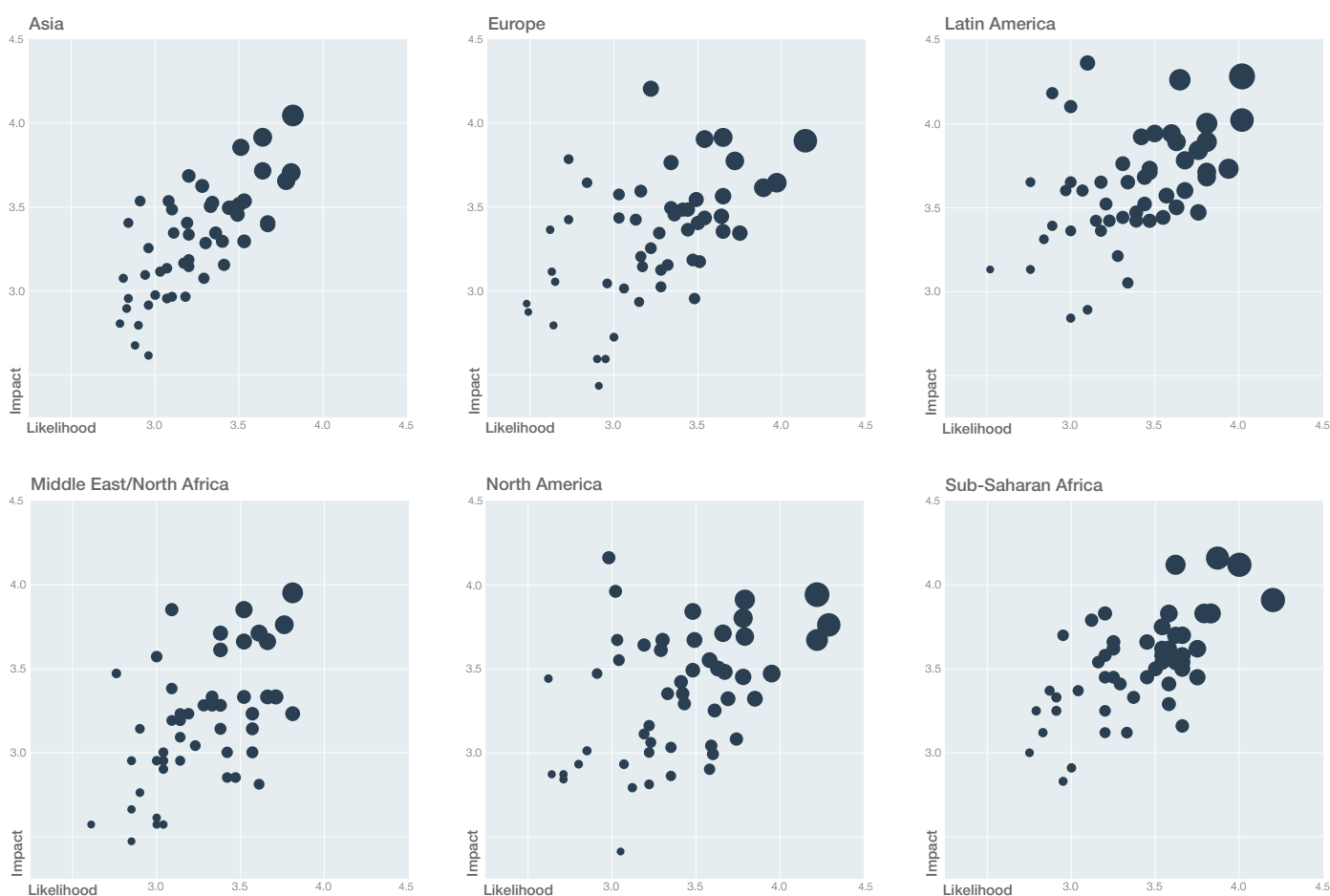
This section explores linkages between the variations above and the background of survey respondents.

By Region

Figure 46 shows one risk landscape scatter plot for each of the geographical regions where survey respondents are located. For example, Latin American and Sub-Saharan African respondents on average assigned a higher impact to the global risks, while those from the Middle East and North Africa chose lower likelihood and impact scores.

Figure 47 shows a more detailed breakdown of the risks that display statistically significant differences across regions. It illustrates significant differences for less than half of the 50 global risks. Among those, residents of Latin America and Sub-Saharan Africa often provided higher average likelihood scores of pair-wise comparisons. On the impact side, it seems that survey participants from North America are often more concerned about risks – especially some of the economic risks – than some of their colleagues in other parts of the world. Within the societal category, there is broad agreement across all regions on the risks, with the exception of **ineffective drug policies**, which had significant differences in both likelihood and impact. There seems to be a greater perceived risk in Latin America, as compared with Asia and Europe, for example. There were no significant differences in perception on the technological category among respondents from different regions.

Figure 46: Comparisons between Regions



Source: World Economic Forum

Figure 47: Comparisons between Regions
(only statistically significant differences are shown)⁴⁹

Risk	Likelihood	Impact
Chronic fiscal imbalances	Europe > Middle East/North Africa North America > Asia North America > Middle East/North Africa	
Unforeseen negative consequences of regulation		Sub-Saharan Africa > Europe Sub-Saharan Africa > Latin America Sub-Saharan Africa > Middle East/North Africa Sub-Saharan Africa > North America
Prolonged infrastructure neglect	North America > Asia North America > Europe North America > Middle East/North Africa North America > Sub-Saharan Africa	North America > Europe
Severe income disparity	North America > Asia North America > Europe	
Unmanageable inflation or deflation	Asia > Europe Asia > North America Sub-Saharan Africa > North America	Latin America > Europe
Hard landing of an emerging economy	Middle East/North Africa > Asia Middle East/North Africa > Europe	
Major systemic financial failure		Europe > Asia Latin America > Asia North America > Asia
Rising greenhouse gas emissions	Europe > Asia North America > Asia North America > Europe	
Failure of climate change adaptation	North America > Asia	
Mismanaged urbanization		Latin America > North America
Land and waterway use mismanagement		Latin America > North America
Vulnerability to geomagnetic storms		Latin America > Middle East/North Africa
Ineffective drug policies	Latin America > Asia Latin America > Europe North America > Europe	Latin America > Europe Latin America > North America
Pervasive entrenched corruption	North America > Asia	
Failure of diplomatic conflict resolution	North America > Asia	
Entrenched organized crime	North America > Asia	Latin America > North America Latin America > Asia Latin America > Europe Sub-Saharan Africa > North America
Widespread illicit trade	North America > Asia	Latin America > North America
Terrorism	North America > Europe	
Militarization of space	Asia > Europe	
Unilateral resource nationalization		Sub-Saharan Africa > Europe Sub-Saharan Africa > Middle East/North Africa
Diffusion of weapons of mass destruction		Latin America > Asia North America > Asia

⁴⁹ With an analysis of variance (ANOVA), it was tested whether or not the means of the sub-groups are all equal. For those risks where they were not all equal, this was then followed by a Sidak post-hoc test to establish which of the pair-wise differences between groups are significant at the 5% level.

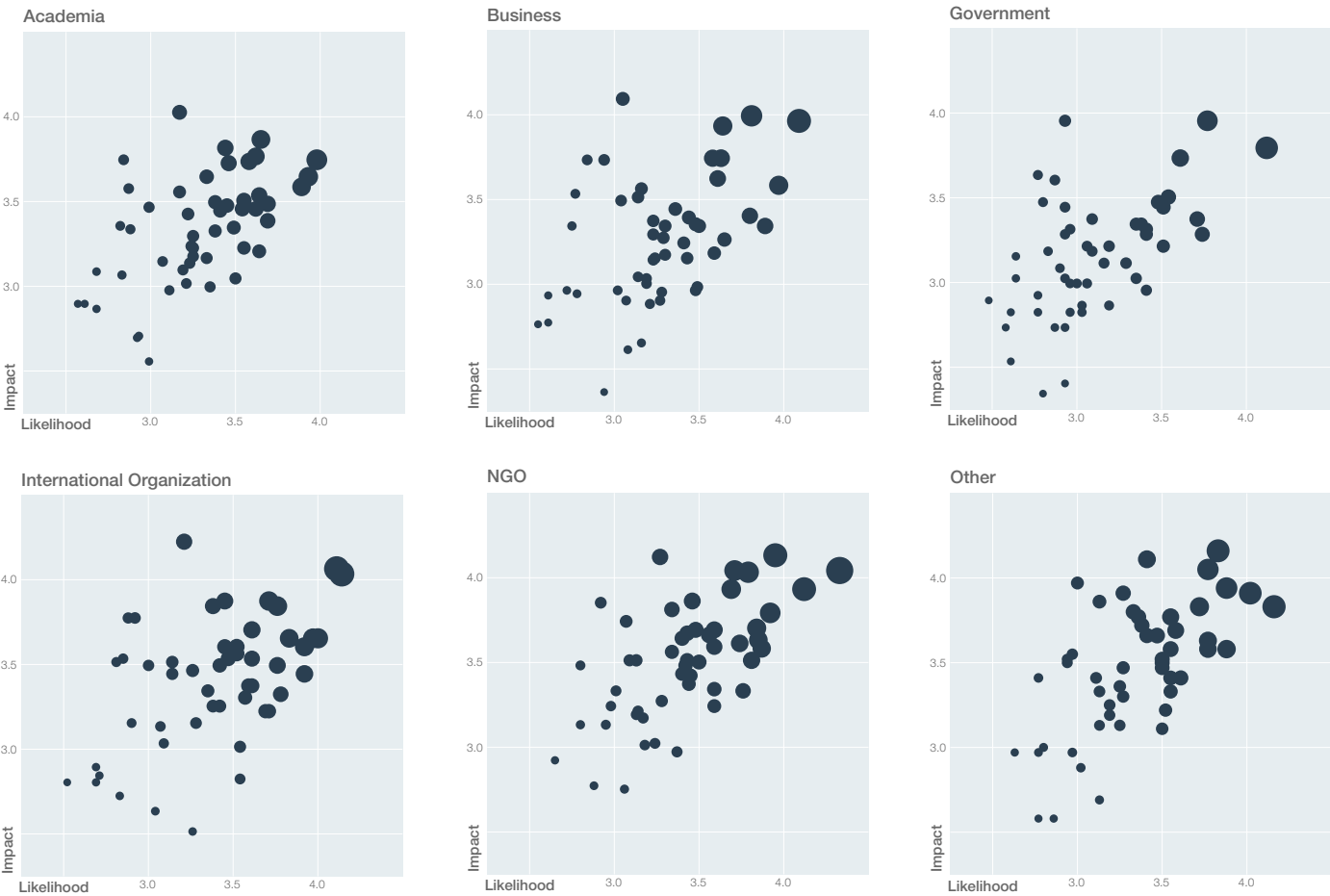
Regional perspectives on the risks of greatest systemic importance are largely similar. The most regional difference occurred in the environmental category. Asian respondents saw the most important systemic risk to be the failure to adapt to climate change, while the Middle East and North Africa gave equal weight to rising greenhouse gas emissions and failure to adapt to climate change, and Sub-Saharan Africa viewed land and waterway use mismanagement as the most systemically important risk.

Affiliation

Similar to the regional variation, there are some intriguing differences between the occupational backgrounds of survey participants. Figure 48 shows that on average, experts from NGOs tend to assign larger impact and likelihood scores than other groups. On the other hand, the average respondent from government has a more benign view of the global risk landscape.

For each of the risks, the same tests as shown in Figure 47 were performed to look at the exact pair-wise differences between sub-groups and their statistical significance. The results are shown in Figure 49.

Figure 48: Comparisons among Organizational Affiliations



Source: World Economic Forum

In those cases where variation exists, it is – perhaps unsurprisingly – often the people from NGOs who exhibit stronger assessments than some of their peers, especially in the environmental category. Also in several geopolitical risk categories, survey respondents

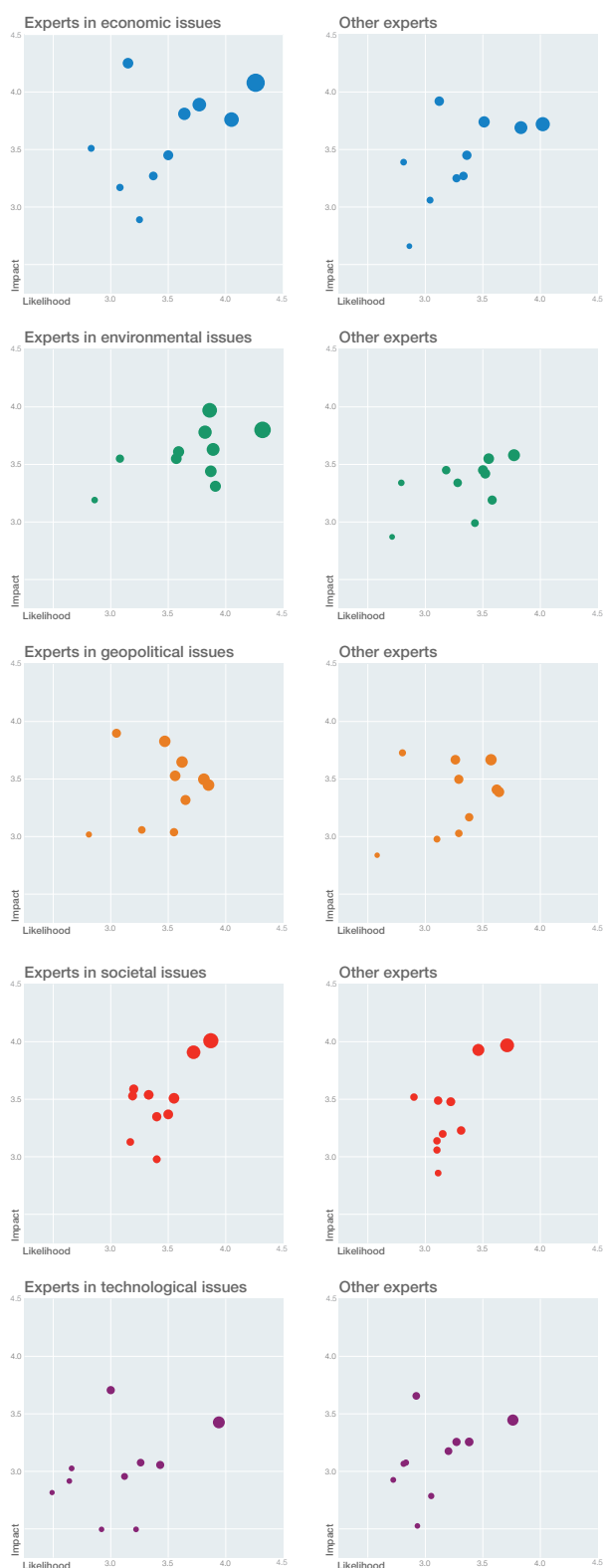
affiliated with International Organizations have higher mean scores than others. At the other end of the scale, individuals working in the private sector and in government assessed many of the risks as lower than others.

Figure 49: Comparisons between Organizational Affiliations
(only statistically significant differences are shown)

Risk	Likelihood	Impact
Unforeseen negative consequences of regulation	Business > Academia	
Severe income disparity	NGO > Academia NGO > Government	NGO > Government
Chronic labour market imbalances	International Organization > Government	International Organization > Government
Rising greenhouse gas emissions	NGO > Government	NGO > Business
Irremediable pollution	NGO > Government	
Persistent extreme weather	NGO > Government	
Failure to adapt to climate change	Academia > Government International Organization > Government NGO > Government	NGO > Academia NGO > Business NGO > Government
Mismanaged urbanization		NGO > Business Other > Business
Unmanaged migration		International Organization > Business NGO > Business Other > Business
Rising religious fanaticism		Academia > Business
Ineffective drug policies		Academia > Business Other > Business
Pervasive entrenched corruption		NGO > Business
Entrenched organized crime	International Organization > Government	International Organization > Business Other > Business
Widespread illicit trade	International Organization > Business International Organization > Government NGO > Government	
Critical fragile states		International Organization > Government NGO > Government
Unintended consequences of nanotechnology	NGO > Academia	
Unintended consequences of climate change mitigation	NGO > Business Other > Business Other > Government	

The perceptions of the most systemically important risks in each category are largely aligned across different occupational backgrounds. Exceptions include responses from International Organizations affiliates, who often chose failure of climate change adaptation as the environmental Centre of Gravity, and mismanagement of population ageing as the societal Centre of Gravity. NGOs have a different view in the economic category, and predominantly see major systemic financial failure as the Centre of Gravity.

Figure 50: Comparisons between the Views of Subject-matter Experts and Their Peers



Source: World Economic Forum

By Subject-area Expertise

Lastly, we look at whether the expertise of survey respondents influenced their assessment of the 50 global risks. Each respondent was asked to identify one or more areas of their expertise in relation to the five categories. Using this information, the risk landscapes were broken down as shown in Figure 50. Experts in their respective subjects tend to assign a higher impact and likelihood than their peers who did not report themselves as experts in that category. The category of technology was an exception to this trend: technology experts tended to have a more benign view of the risks.

Figure 51 presents the results of the T-tests of mean comparison that identified the risks where discrepancies are statistically significant.⁵⁰ This analysis confirms the observations made from looking at the scatter plots. Overall, there are very few global risks that experts ranked with a lower mean score, and most of them came from the technological category. Only in two cases were these significant: the likelihood of **unintended consequences of nanotechnology** and **failure of intellectual property regime**.

Figure 51: Comparisons between the Views of Subject-matter Experts and Their Peers

Risks where subject-matter experts gave a significantly higher rating in terms of likelihood or impact than others are indicated with a (+), those where the experts gave a lower rating with a (-).

Risks	Likelihood	Impact
Chronic fiscal imbalances	+	+
Extreme volatility in energy and agriculture prices	+	
Unforeseen negative consequences of regulations	+	+
Recurring liquidity crises	+	+
Chronic labour market imbalances	+	+
Major systemic financial failure		+
Rising greenhouse gas emissions	+	
Failure of climate change adaptation	+	
Irremediable pollution	+	
Land and waterway use mismanagement	+	
Species overexploitation	+	+
Mismanaged urbanization	+	+
Unprecedented geophysical destruction	+	
Persistent extreme weather	+	+
Vulnerability to geomagnetic storms		+
Mismanagement of population ageing	+	+
Unsustainable population growth	+	
Unmanaged migration	+	
Rising rates of chronic disease	+	+
Food shortage crises	+	
Ineffective drug policies	+	
Pervasive entrenched corruption	+	
Critical fragile states	+	
Global governance failure	+	
Failure of diplomatic conflict resolution	+	
Entrenched organized crime	+	
Widespread illicit trade	+	
Diffusion of weapons of mass destruction	+	
Militarization of space	+	
Unintended consequences of nanotechnology	-	
Proliferation of orbital debris	+	
Failure of intellectual property regime		-

⁵⁰ Alpha-level used: 5%. Mean differences and t-values for each of the risks are available upon request.

There were no differences in the choice of Centres of Gravity between subject-matter experts and their peers in other expert areas.

Box 6: How Confident Are We about the State of the World?

To answer this question, experts from academia, business, governments and NGOs are polled every quarter in a new joint initiative of the World Economic Forum's Risk Response Network and Global Agenda Councils.

The Global Confidence Index – the only research initiative of its kind that targets over 1,000 international experts – asks survey participants about their confidence over the next 12 months on the state of the global economy, global governance and global cooperation. Respondents are also asked how likely they think economic, environmental, geopolitical, societal and technological disruptions will be in the following 12 months. The data provides a dynamic assessment of which – if any – of the five categories may introduce a shock to the global system.

The first two surveys from 2011 have yielded interesting results. Experts remained pessimistic about the state of the global economy and global governance over the last two quarters, yet are more optimistic about the state of global cooperation to address these risks.

Over the longer term, the Global Confidence Index will produce time series data that compares changes of perceptions over several years, as well as regression analysis with other indicators. For more information please visit the Global Confidence Index website: <http://www.weforum.org/ConfidenceIndex>.

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