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Insight Report

The Global Risks Report 2017

12th Edition

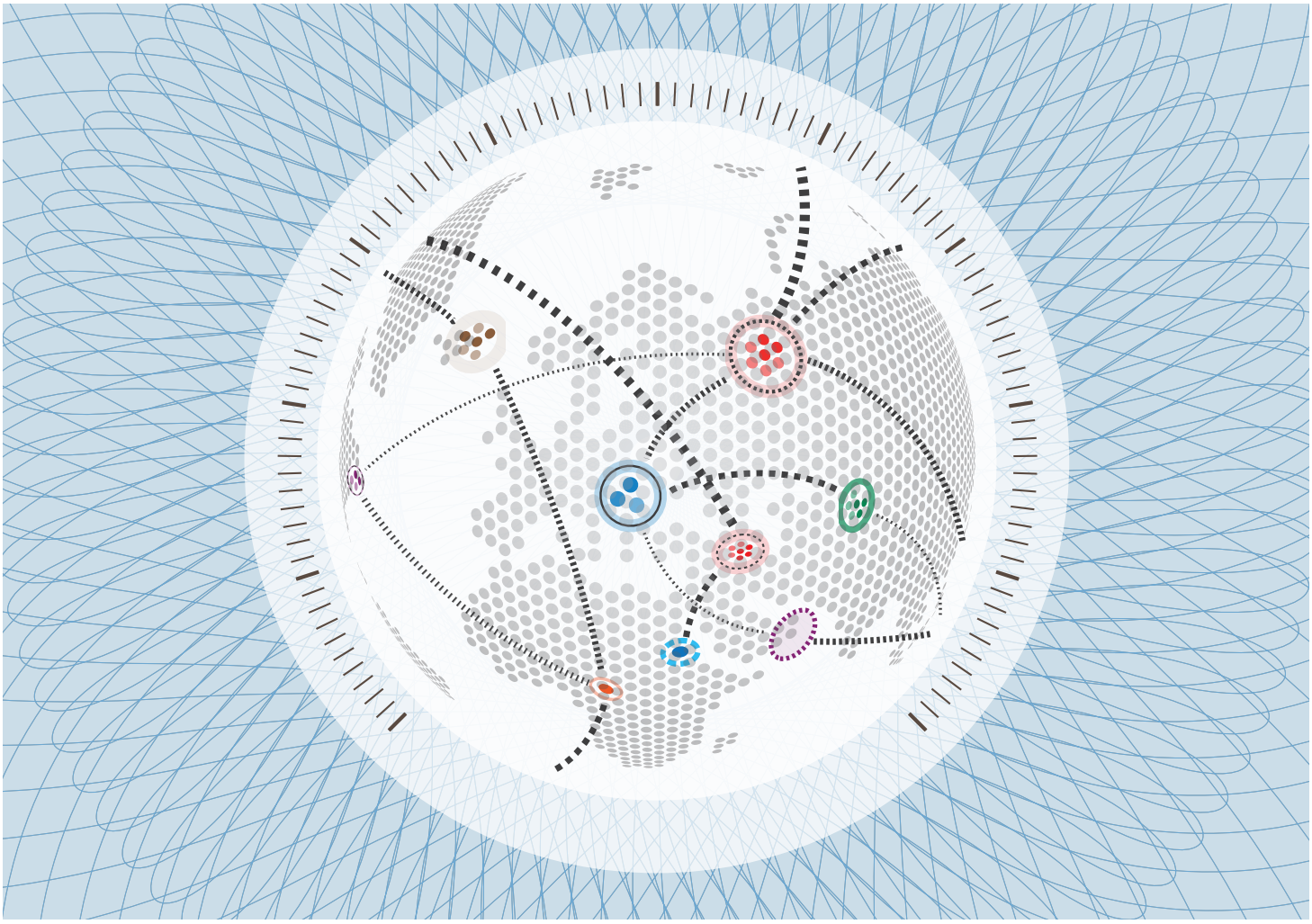

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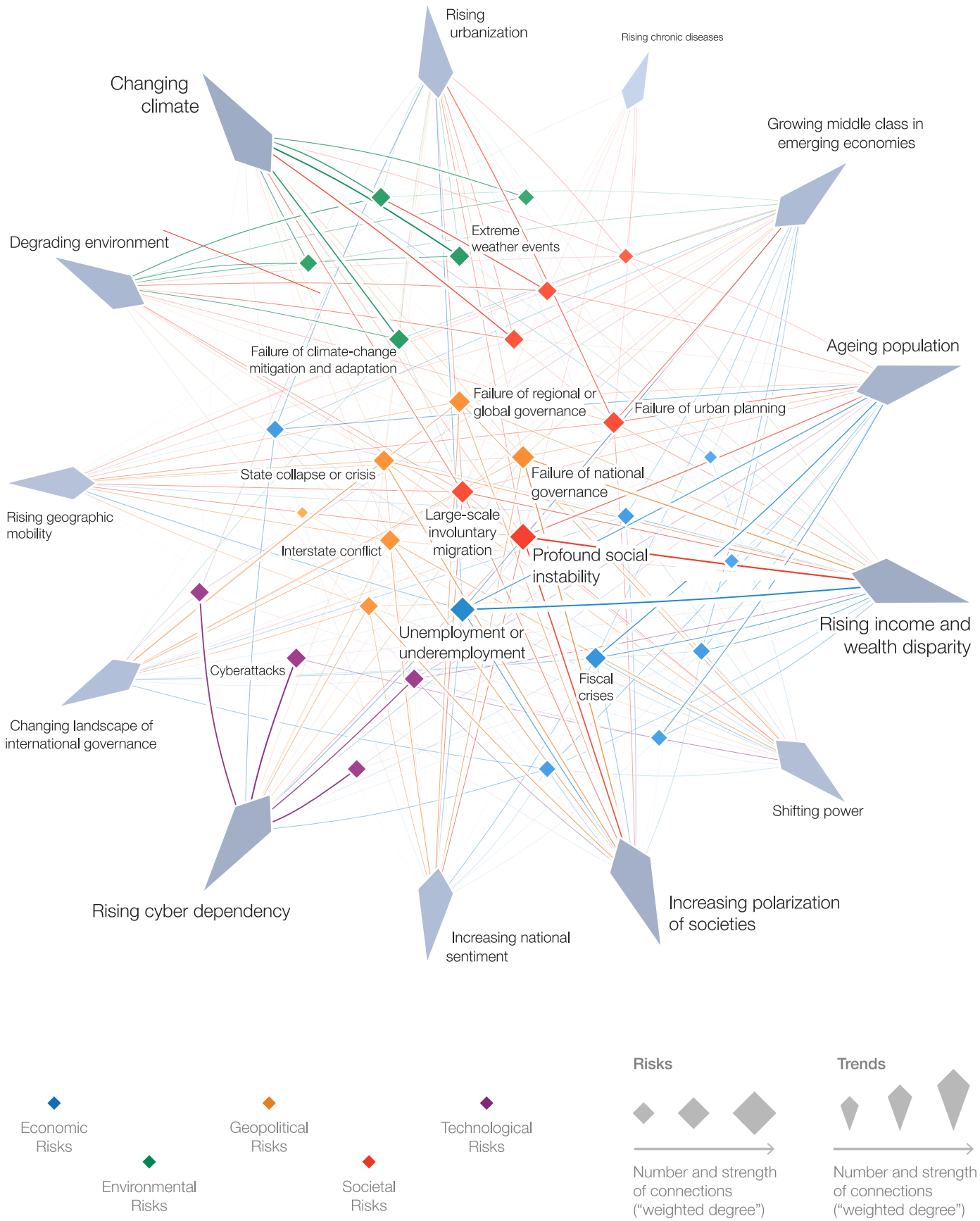
Figure 1: The Risks-Trends Interconnections Map



Source: World Economic Forum Global Risks Perception Survey 2016
Note: Survey respondents were asked to select the three trends that are the most important in shaping global development in the next 10 years. For each of the three trends identified, respondents were asked to select the risks that are most strongly driven by those trends. The global risks with the most connections to trends are spelled out in the figure. See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated; see Appendix A for the full name and description

Figure 2: The Evolving Risks Landscape, 2007-2017

Top 5 Global Risks in Terms of Likelihood

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1st	Breakdown of critical information infrastructure	Asset price collapse	Asset price collapse	Asset price collapse	Storms and cyclones	Severe income disparity	Severe income disparity	Income disparity	Interstate conflict with regional consequences	Large-scale involuntary migration	Extreme weather events
2nd	Chronic disease in developed countries	Middle East instability	Slowing Chinese economy (<6%)	Slowing Chinese economy (<6%)	Flooding	Chronic fiscal imbalances	Chronic fiscal imbalances	Extreme weather events	Extreme weather events	Extreme weather events	Large-scale involuntary migration
3rd	Oil price shock	Failed and failing states	Chronic disease	Chronic disease	Corruption	Rising greenhouse gas emissions	Rising greenhouse gas emissions	Unemployment and underemployment	Failure of national governance	Failure of climate-change mitigation and adaptation	Major natural disasters
4th	China economic hard landing	Oil and gas price spike	Global governance gaps	Fiscal crises	Biodiversity loss	Cyber attacks	Water supply crises	Climate change	State collapse or crisis	Interstate conflict with regional consequences	Large-scale terrorist attacks
5th	Asset price collapse	Chronic disease, developed world	Retrenchment from globalization (emerging)	Global governance gaps	Climate change	Water supply crises	Mismanagement of population ageing	Cyber attacks	High structural unemployment or underemployment	Major natural catastrophes	Massive incident of data fraud/theft

Top 5 Global Risks in Terms of Impact

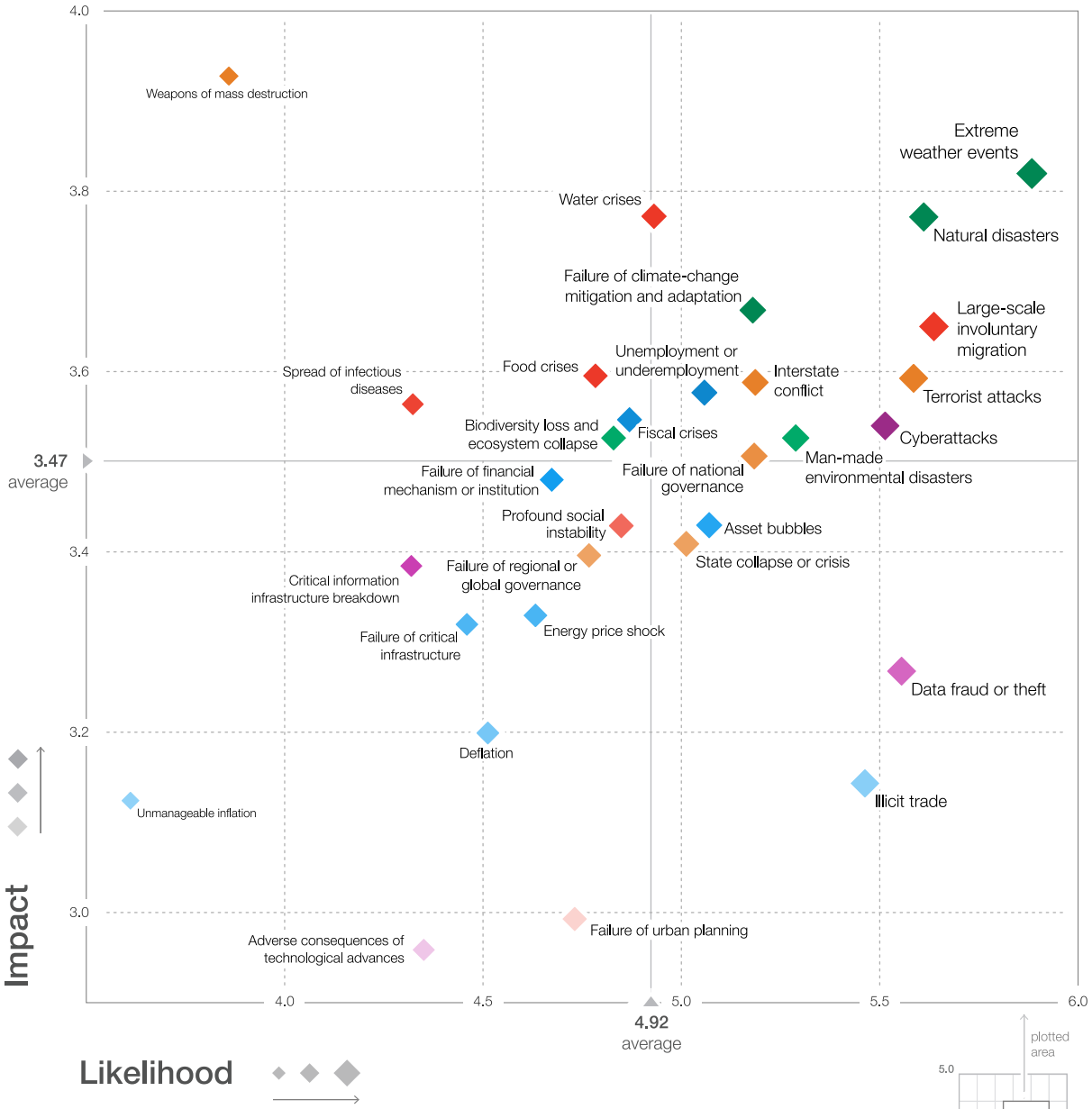
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1st	Asset price collapse	Asset price collapse	Asset price collapse	Asset price collapse	Fiscal crises	Major systemic financial failure	Major systemic financial failure	Fiscal crises	Water crises	Failure of climate-change mitigation and adaptation	Weapons of mass destruction
2nd	Retrenchment from globalization	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)	Retrenchment from globalization (developed)	Climate change	Water supply crises	Water supply crises	Climate change	Rapid and massive spread of infectious diseases	Weapons of mass destruction	Extreme weather events
3rd	Interstate and civil wars	Slowing Chinese economy (<6%)	Oil and gas price spike	Oil price spikes	Geopolitical conflict	Food shortage crises	Chronic fiscal imbalances	Water crises	Weapons of mass destruction	Water crises	Water crises
4th	Pandemics	Oil and gas price spike	Chronic disease	Chronic disease	Asset price collapse	Chronic fiscal imbalances	Diffusion of weapons of mass destruction	Unemployment and underemployment	Interstate conflict with regional consequences	Large-scale involuntary migration	Major natural disasters
5th	Oil price shock	Pandemics	Fiscal crises	Fiscal crises	Extreme energy price volatility	Extreme volatility in energy and agriculture prices	Failure of climate-change mitigation and adaptation	Critical information infrastructure breakdown	Failure of climate-change mitigation and adaptation	Severe energy price shock	Failure of climate-change mitigation and adaptation

Economic | Environmental | Geopolitical | Societal | Technological

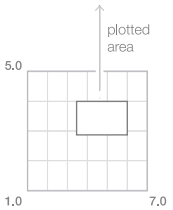
Source: World Economic Forum 20017-2017, Global Risks Reports

Note: Global risks may not be strictly comparable across years, as definitions and the set of global risks have evolved with new issues emerging on the 10-year horizon. For example, cyberattacks, income disparity and unemployment entered the set of global risks in 2012. Some global risks were reclassified: water crises and rising income disparity were re-categorized first as societal risks and then as a trend in the 2015 and 2016 Global Risks Reports, respectively. The 2006 edition of the Global Risks Report did not have a risks landscape

Figure 3: The Global Risks Landscape 2017



Likelihood



Top 10 risks in terms of
Likelihood

1. Extreme weather events
2. Large-scale involuntary migration
3. Natural disasters
4. Terrorist attacks
5. Data fraud or theft
6. Cyberattacks
7. Illicit trade
8. Man-made environmental disasters
9. Interstate conflict
10. Failure of national governance

Top 10 risks in terms of
Impact

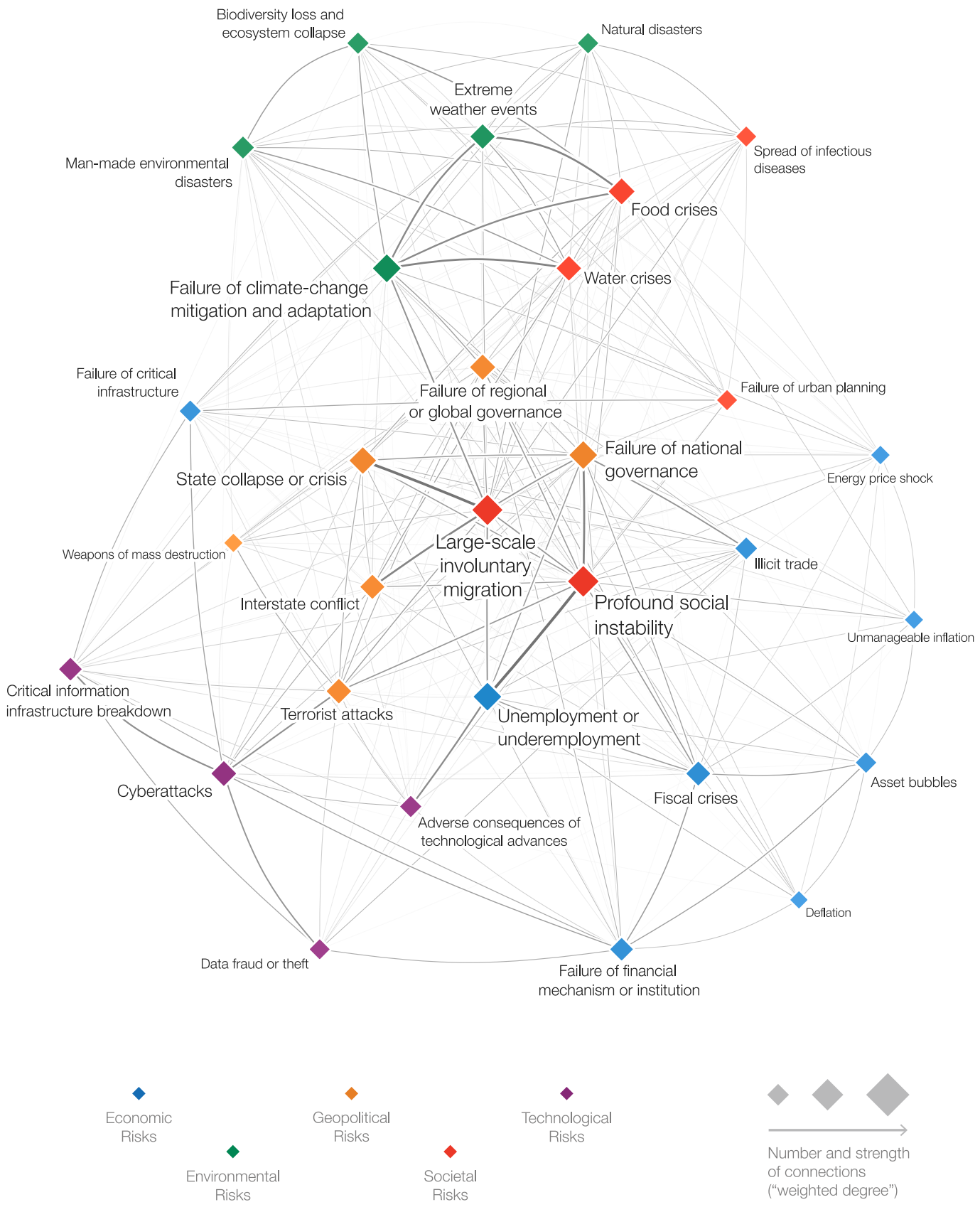
1. Weapons of mass destruction
2. Extreme weather events
3. Water crises
4. Natural disasters
5. Failure of climate-change mitigation and adaptation
6. Large-scale involuntary migration
7. Food crises
8. Terrorist attacks
9. Interstate conflict
10. Unemployment or underemployment

Categories

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

Source: World Economic Forum Global Risks Perception Survey 2016
Note: Survey respondents were asked to assess the likelihood of the individual global risk on a scale of 1 to 7, 1 representing a risk that is not likely to happen and 7 a risk that is very likely to occur. They also assess the impact on each global risk on a scale of 1 to 5 (1: minimal impact, 2: minor impact, 3: moderate impact, 4: severe impact and 5: catastrophic impact). See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated; see Appendix A for the full name and description

Figure 4: The Global Risks Interconnections Map 2017



Source: World Economic Forum Global Risks Perception Survey 2016
Note: Survey respondents were asked to identify between three and six pairs of global risks they believe to be most interconnected. See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated; see Appendix A for the full name and description

The Global Risks Report 2017
12th Edition

Strategic Partners
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Oxford Martin School, University of Oxford
Wharton Risk Management and Decision Processes Center, University of Pennsylvania

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By Klaus Schwab

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Preface

The year 2016 has seen profound shifts in the way we view global risks. Societal polarization, income inequality and the inward orientation of countries are spilling over into real-world politics. Through recent electoral results in G7 countries, these trends are set to have a lasting impact on the way economies act and relate to each other. They are also likely to affect global risks and the interconnections between them.

Against the background of these developments, this year's *Global Risks Report* explores five gravity centres that will shape global risks. First, continued slow growth combined with high debt and demographic change creates an environment that favours financial crises and growing inequality. At the same time, pervasive corruption, short-termism and unequal distribution of the benefits of growth suggest that the capitalist economic model may not be delivering for people. The transition towards a more multipolar world order is putting global cooperation under strain. At the same time, the Fourth Industrial Revolution is fundamentally transforming societies, economies, and ways of doing business. Last but not least, as people seek to reassert identities that have been blurred by globalization, decision-making is increasingly influenced by emotions.

In addition to these gravity centres, this year's *Global Risks Report* presents deep-dive discussions of risks posed by ongoing political and societal transformations, including challenges to democracy, closing space for civil society, and outmoded social protection systems. It also discusses risks related to emerging technologies of the Fourth Industrial Revolution and the associated governance challenges.

As in previous years, the analysis contained in this *Report* builds on the annual Global Risks Perception Survey, completed by almost 750 members of the World Economic Forum's global multistakeholder community.

The year 2017 will present a pivotal moment for the global community. The threat of a less cooperative, more inward-looking world also creates the opportunity to address global risks and the trends that drive them. This will require responsive and responsible leadership with a deeper commitment to inclusive development and equitable growth, both nationally and globally. It will also require collaboration across multiple interconnected systems, countries, areas of expertise, and stakeholder groups with the aim of having a greater societal impact. We hope that *The Global Risks Report 2017* and the subsequent deliberations at the World Economic Forum's Annual Meeting 2017 will contribute to a debate about pragmatic solutions.

Klaus Schwab
Founder and Executive Chairman
World Economic Forum

Foreword

As one of the Forum's flagship reports, *The Global Risks Report* has been a collaborative effort since its first edition in 2006. It draws on the unique expertise available within the Forum itself and its different communities and knowledge networks. It also builds firmly on the Forum's ongoing research, projects, debates and initiatives. As well as reflecting the views of leaders from our various communities through the Global Risks Perception Survey, the insights presented here are the result of numerous discussions, consultations, and workshops.

With this in mind, we would like to thank our Strategic *Report* Partners, Marsh & McLennan Companies and Zurich Insurance Group, represented on the Steering Board by John Drzik, President, Global Risk and Specialties, Marsh; and Cecilia Reyes, Group Chief Risk Officer, Zurich Insurance Group. Furthermore, Professor Schwab is grateful to our Academic Advisers the National University of Singapore, Oxford Martin School at the University of Oxford, and the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania.

The *Report* has greatly benefited from the dedication and valuable guidance of the members of the Global Risks 2017 Advisory Board. Members are Rolf Alter, Organisation for Economic Co-operation and Development (OECD); Sharan Burrow, International Trade Union Confederation (ITUC); Winnie Byanyima, Oxfam International; Marie-Valentine Florin, International Risk Governance Council (IRGC); Al Gore, Generation Investment Management; Donald Kaberuka, Harvard University; Steven Kou, National University of Singapore; Julian Laird, Oxford Martin School; Pascal Lamy, Jacques Delors Institute; Ursula von der Leyen, Federal Minister of Defence of Germany; Maleeha Lodhi, Ambassador and Permanent Representative of Pakistan to the United Nations; Gary Marchant, Arizona State University; Erwann Michel-Kerjan, Wharton Risk Management and Decision Processes Center, University of Pennsylvania; Nicolas Mueller, Federal Chancellery of Switzerland; Moisés Naím, Carnegie Endowment for International Peace; Kirstjen Nielsen, George Washington University Center for Cyber and Homeland Security; Naomi Oreskes, Harvard University; Jonathan Ostry, International Monetary Fund; Nouriel Roubini, New York University; John Scott, Zurich Insurance Group; Richard Smith-Bingham, Marsh & McLennan Companies; Michelle Tuveson, Centre for Risk Studies, University of Cambridge Judge Business School; Ngaire Woods, University of Oxford; and Sandra Wu Wen-Hsiu, Japan Asia Group Limited.

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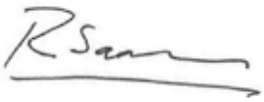
Last but not least, we would like to thank the Global Risks Perception Survey 2016 review group, respondents who completed the Global Risks Perception Survey and the participants in the Global Risks workshops.

Margareta Drzeniek Hanouz
Head of Competitiveness and Risks and Member of the Executive Committee



Richard Samans
Head of the Centre for the Global Agenda, Member of the Managing Board

Executive Summary

For over a decade, *The Global Risks Report* has focused attention on the evolution of global risks and the deep interconnections between them. The *Report* has also highlighted the potential of persistent, long-term trends such as inequality and deepening social and political polarization to exacerbate risks associated with, for example, the weakness of the economic recovery and the speed of technological change. These trends came into sharp focus during 2016, with rising political discontent and disaffection evident in countries across the world. The highest-profile signs of disruption may have come in Western countries – with the United Kingdom's vote to leave the European Union and President-elect Donald Trump's victory in the US presidential election – but across the globe there is evidence of a growing backlash against elements of the domestic and international status quo.

The Global Risks Landscape

One of the key inputs to the analysis of *The Global Risks Report* is the Global Risks Perception Survey (GRPS), which brings together diverse perspectives from various age groups, countries and sectors: business, academia, civil society and government.

This year's findings are testament to five key challenges that the world now faces. The first two are in the economic category, in line with the fact that *rising income and wealth disparity* is rated by GRPS respondents as the most important trend in determining global developments over the next 10 years. This points to the need for **reviving economic growth**, but the growing mood of anti-establishment populism suggests we may have passed the stage where this alone would remedy fractures in society: **reforming market capitalism** must also be added to the agenda.

With the electoral surprises of 2016 and the rise of once-fringe parties stressing national sovereignty and traditional values across Europe and beyond, the societal trends of *increasing polarization* and *intensifying national sentiment* are ranked among the top five. Hence the next challenge: **facing up to the importance of identity and community**. Rapid changes of attitudes in areas such as gender, sexual orientation, race, multiculturalism, environmental protection and international cooperation have led many voters – particularly the older and less-educated ones – to feel left behind in their own countries. The resulting cultural schisms are testing social and political cohesion and may amplify many other risks if not resolved.

Although anti-establishment politics tends to blame globalization for deteriorating domestic job prospects, evidence suggests that **managing technological change** is a more important challenge for labour markets. While innovation has historically created new kinds of jobs as well as destroying old kinds, this process may be slowing. It is no coincidence that challenges to social cohesion and policy-makers' legitimacy are coinciding with a highly disruptive phase of technological change.

The fifth key challenge is to **protect and strengthen our systems of global cooperation**. Examples are mounting of states seeking to withdraw from various international cooperation mechanisms. A lasting shift in the global system from an outward-looking to a more inward-looking stance would be a highly disruptive development. In numerous areas – not least the ongoing crisis in Syria and the migration flows it has created – it is ever clearer how important global cooperation is on the interconnections that shape the risk landscape.

Further challenges requiring global cooperation are found in the environmental category, which this year stands out in the GRPS. Over the course of the past decade, a cluster **of environment-related risks** – notably *extreme weather events* and *failure of climate change mitigation and adaptation* as well as *water crises* – has emerged as a consistently central feature of the GRPS risk landscape, strongly interconnected with many other risks, such as conflict and migration. This year, environmental concerns are more prominent than ever, with all five risks in this category assessed as being above average for both impact and likelihood.

Social and Political Challenges

After the electoral shocks of the last year, many are asking whether the crisis of mainstream political parties in Western democracies also represents a deeper crisis with **democracy** itself. The first of three "risks in focus" considered in Part 2 of the *Report* assesses three related reasons to think so: the impacts of rapid economic and technological change; the deepening of social and cultural polarization; and the emergence of "post-truth" political debate. These challenges to the political process bring into focus policy questions such as how to make economic growth more inclusive and how to reconcile growing identity nationalism with diverse societies.

The second risk in focus also relates to the functioning of society and politics: it looks at how civil society organizations and individual activists are increasingly experiencing government crackdowns on **civic space**, ranging from restrictions on foreign funding to surveillance of digital activities and even physical violence. Although the stated aim of such measures is typically to protect against security threats, the effects have been felt by academic, philanthropic and humanitarian entities and have the potential to erode social, political and economic stability.

An issue underlying the rise of disaffection with the political and economic status quo is that **social protection** systems are at breaking point. The third risk in focus analyses how the underfunding of state systems is coinciding with the decline of employer-backed social protection schemes; this is happening while technological change means stable, long-term jobs are giving way to self-employment in the "gig economy". The chapter suggests some of the innovations that will be needed to fill the gaps that are emerging in our social protection systems as individuals shoulder greater responsibility for costs associated with economic and social risks such as unemployment, exclusion, sickness, disability and old age.

Managing the Fourth Industrial Revolution

The final part of this *Report* explores the relationship between global risks and the emerging technologies of the Fourth Industrial Revolution (4IR). We face a pressing **governance challenge** if we are to construct the rules, norms, standards, incentives, institutions and other mechanisms that are needed to shape the development and deployment of these technologies. How to govern fast-developing technologies is a complex question: regulating too heavily too quickly can hold back progress, but a lack of governance can exacerbate risks as well as creating unhelpful uncertainty for potential investors and innovators.

Currently, the governance of emerging technologies is patchy: some are regulated heavily, others hardly at all because they do not fit under the remit of any existing regulatory body. Respondents to the GRPS saw two emerging technologies as being most in need of better governance: biotechnologies – which tend to be highly regulated, but in a slow-moving way – and artificial intelligence (AI) and robotics, a space that remains only lightly governed. A chapter focusing on the **risks associated with AI** considers the potential risks associated with letting greater decision-making powers move from humans to AI programmes, as well as the debate about whether and how to prepare for the possible development of machines with greater general intelligence than humans.

The *Report* concludes by assessing the risks associated with how technology is reshaping **physical infrastructure**: greater interdependence among different infrastructure networks is increasing the scope for systemic failures – whether from cyberattacks, software glitches, natural disasters or other causes – to cascade across networks and affect society in unanticipated ways.

Introduction

This 12th edition of *The Global Risks Report* is published at a time of heightened political uncertainty, following a year of unexpected electoral results, particularly in the United States and the United Kingdom. Polarized societies and political landscapes are taking centre stage in many countries, with deepening generational and cultural divisions amplifying the risks associated with sluggish economic recovery and accelerating technological change.

These tensions have been building for some time, and over the past 10 years a nexus of social, political and economic fragilities has been a consistent focus of *The Global Risks Report*. The events of 2016 should serve as a wake-up call and prompt us to reassess our preparedness in the face of an evolving risk landscape.

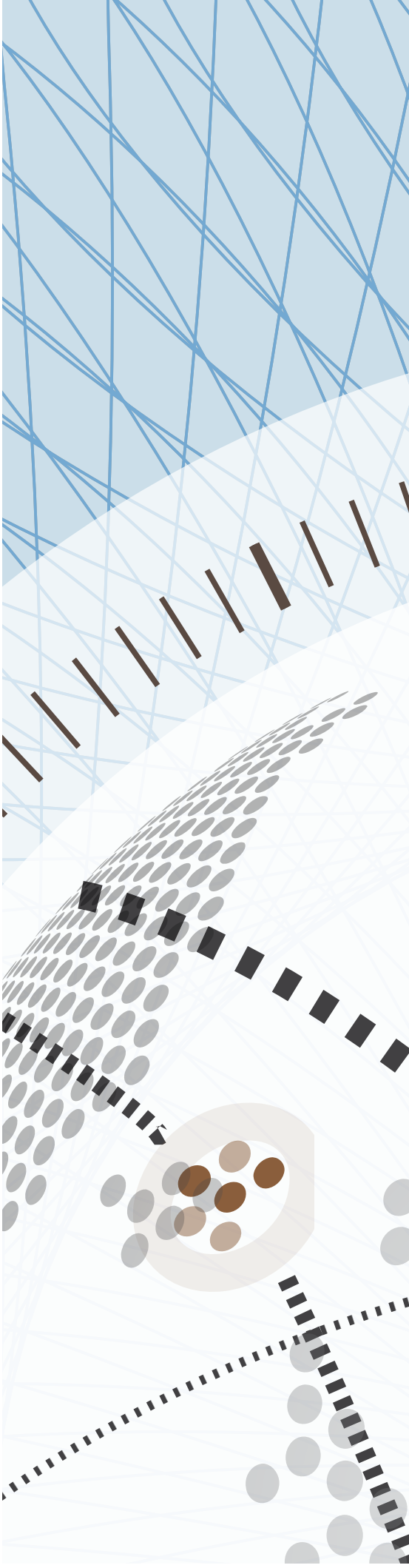
While we should be wary of attributing too much influence to a series of very recent electoral results, the consequences of which are still unknown, major unexpected events can serve as inflection points. Long-term trends – such as persistent inequality and deepening polarization, which ranked first and third in perceived importance in the Global Risks Perception Survey (GRPS) this year – can build to a point at which they become triggers for change. This kind of change might involve risks intensifying or crystallizing, but it is important to recognize that shocks and releases of tension might also lead to a brightening of the risk outlook. We are in a period of flux; paradoxically this is therefore a time when things could improve.

The world is undergoing multiple complex transitions: towards a lower-carbon future; towards technological change of unprecedented depth and speed; towards new global economic and geopolitical balances. Managing these transitions and the deeply interconnected risks they entail will require long-term thinking, investment and international cooperation. It will also require policy-makers to bring voters with them – one of the lessons of 2016 is that we are very far from consensus on how to proceed.

This year's *Global Risks Report* takes as its starting point the societal and political polarization that besets an increasing number of countries and that looks set to be a determining feature of the political landscape not just for the next few years but for the next few electoral cycles. In **Part 1**, the *Report* draws on the trends and risks highlighted in the latest GRPS to outline the key challenges that the world now faces: reviving economic growth; reforming market capitalism; facing up to the importance of identity and community; managing technological change; protecting and strengthening our systems of global cooperation; and deepening our efforts to protect the environment.

Part 2 explores three social and political risks in greater depth. The first chapter considers whether recent political trends amount to a crisis of Western democracy. It looks at underlying patterns that have led to a weakening of democratic legitimacy and points to three strategies that might help to restore it. The second piece highlights the importance of civil society in mitigating risks and assesses trends towards the curtailment of civil society organizations' freedom to operate. The final chapter in this part of the *Report* looks at one of the gravest long-term challenges facing the world: how to build systems of social protection that can cope with the seismic demographic, economic and other changes that have transfigured social structures and individual lives over the last three decades.

Part 3 turns towards technology, which is at once a source of disruption and polarization and an inevitable part of whatever responses to these trends we choose to pursue. Informed by the results of a special GRPS module on emerging technologies, the urgency of the governance challenge in this area is stressed. This is followed by two in-depth assessments of specific technological risks: first, in relation to artificial intelligence, and second, in relation to our rapidly changing physical infrastructure needs and vulnerabilities.



Part 1: Global Risks 2017

Years of building pressure in many parts of the world, at least since the global financial crisis,[1] crystallized into dramatic political results during 2016 as public disaffection with the status quo gained traction. In the West, consensus expectations were defied by the United Kingdom's decision to leave the European Union, by President-elect Donald Trump's victory in the United States and by the Italian electorate's rejection of Matteo Renzi's constitutional reforms. The implications of results such as these are potentially far-reaching – some people question whether the West has reached a tipping point and might now embark on a period of deglobalization.[2] But the uncertainty and instability that characterized 2016 are not Western phenomena alone: we saw variations of them in countries across the world, including Brazil, the Philippines and Turkey.

These developments should not surprise us. Over the past decade *The Global Risks Report* has drawn attention each year to a persistent cluster of economic, social and geopolitical factors that have helped shape the global risks landscape. In 2007 and 2008, for example, *The Global Risk Report*'s rankings showed deglobalization in advanced economies as tied for the risk with the highest impact; in 2011, the *Report* focused on "economic disparity and global governance failures"; in 2014 it highlighted "societal concerns includ[ing] the breakdown of social structures, the decline of trust in institutions, the lack of leadership and persisting gender inequalities"; and in 2015 it observed that "the fragility of societies is of increasing concern" and cautioned against excessive economic optimism, noting that it might "reflect a false sense of control, as history shows that people … are often taken by surprise by the same risks."[3]

That discontent with the current order has now become an election-winning proposition clearly increases the urgency of understanding and responding to these global risks. The World Economic Forum has identified five key challenges that will require greater global attention and action:

- fostering greater solidarity and long-term thinking in market capitalism,
- revitalizing global economic growth,
- recognizing the importance of identity and inclusiveness in healthy political communities,
- mitigating the risks and exploiting the opportunities of the Fourth Industrial Revolution, and
- strengthening our systems of global cooperation.

The remainder of Part 1 looks at each of these challenges, drawing on the latest Global Risks Perception Survey (GRPS) to identify potential trigger points that might create new risks, exacerbate existing risks or – an under-appreciated possibility – provide opportunities to do things differently in a way that mitigates risks. Part 1 concludes with a reflection on environmental risk, which again stands out in the GRPS as a source of concern, and which would be particularly vulnerable to any loss of momentum in global cooperation.

Economy: Growth and Reform

Despite unprecedented levels of peace and global prosperity, in many countries a mood of economic malaise has contributed to anti-establishment, populist politics and a backlash against globalization. The weakness of the economic recovery following the global financial crisis is part of this story, but boosting growth alone would not remedy the deeper fractures in our political economy. More fundamental reforms to market capitalism may be needed to tackle, in particular, an apparent lack of solidarity between those at the top of national income and wealth distributions and those further down.

Economic concerns pervade the latest GRPS results. This is not immediately evident from the evolution of the top-five risks by impact and likelihood, as illustrated in Figure 2 (inside front cover), which shows economic risks fading in prominence since the height of the global financial crisis, and missing entirely for the first time in the latest survey. However, in addition to asking respondents to assess the impact and likelihood of individual risks, the survey asks ask them to consider the influences and interconnections that shape the risk landscape. Here the economy is paramount. "Growing income and wealth disparity" is seen by respondents as the trend most likely to determine global developments over the next 10 years (see Table 1.1), and when asked to identify interconnections between risks, the most frequently mentioned pairing was that of unemployment and social instability (see Table 1.2 and Appendix A).

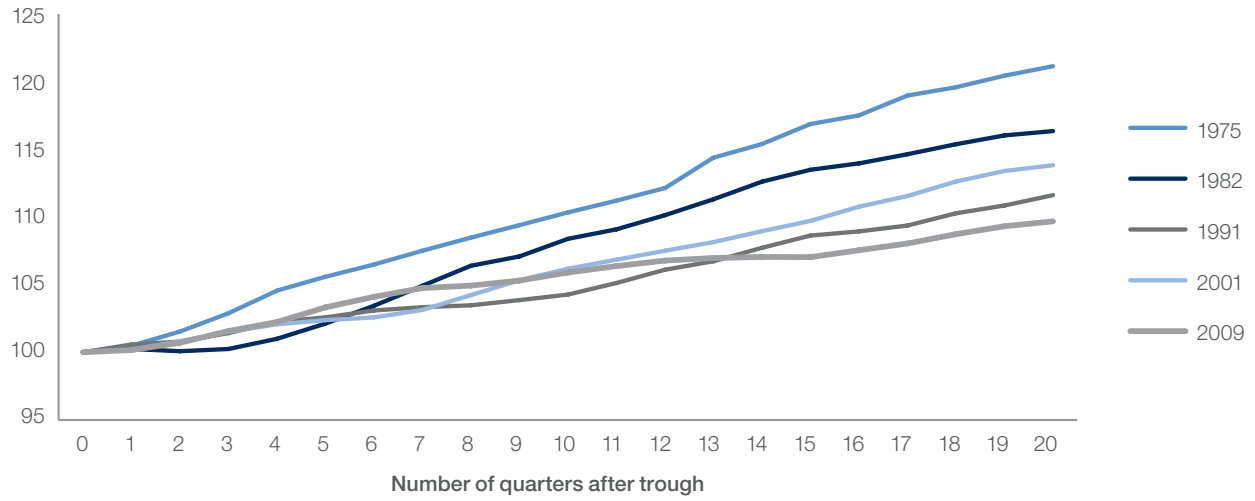
Table 1.1: Top 5 Trends that Determine Global Developments

1	Rising Income and wealth disparity
2	Changing climate
3	Increasing polarization of societies
4	Rising cyber dependency
5	Ageing population

Source: World Economic Forum Global Risks Perception Survey 2016.

Globally, inequality between countries has been decreasing at an accelerating pace over the past 30 years.[4] Within some countries, however, the data tell a different story. Inequality had been falling consistently in the industrialized world since the beginning of the 20th century, but since the 1980s the share of income going to the top 1% has increased in the United States, United Kingdom, Canada, Ireland and Australia (although not in Germany, Japan, France, Sweden, Denmark or the Netherlands).[5] Reasons include skill-biased technological change[6] – which increases the returns to education – combined with scale effects as markets became more interconnected, increasing global competition for talent. Among other things, this has led to an increase in CEO compensation as firms have become larger.[7] Global communications have also driven up returns for individuals who can successfully cater to a global audience – what Sherwin Rosen described as "the economics of superstars".[8]

Figure 1.1: The Pace of Global Recoveries since 1975
OECD real GDP; seasonally adjusted; rebased to 100 at trough of each slowdown



Source: OECD *Quarterly National Accounts Dataset.*

In advanced economies, the incomes of the traditionally well-off middle classes have grown at a comparatively slower pace[9] – and slower also than the incomes of the emerging middle classes of countries in Latin America, Africa, and particularly Asia.[10] The slow pace of economic recovery since 2008 has intensified local income disparities,[11] with a more dramatic impact on many households than aggregate national income data would suggest. This has contributed to anti-establishment sentiment in advanced economies, and although emerging markets have seen poverty fall at record speed,[12] they have not been immune to rising public discontent – evident, for example, in large demonstrations against corruption across Latin America. Larrain et al. argue that rising prosperity and a growing middle class lead to greater demands for better government and public goods, which governments across the developing world have been unable to meet.[13]

Table 1.2: Most Important Risks' Interconnections

1	Unemployment and underemployment Profound social instability
2	Large-scale involuntary migration State collapse or crisis
3	Failure of climate-change mitigation and adaption Water crises
4	Failure of national governance Profound social instability
5	Interstate conflict with regional consequences Large-scale involuntary migration

Source: World Economic Forum Global Risks Perception Survey 2016.

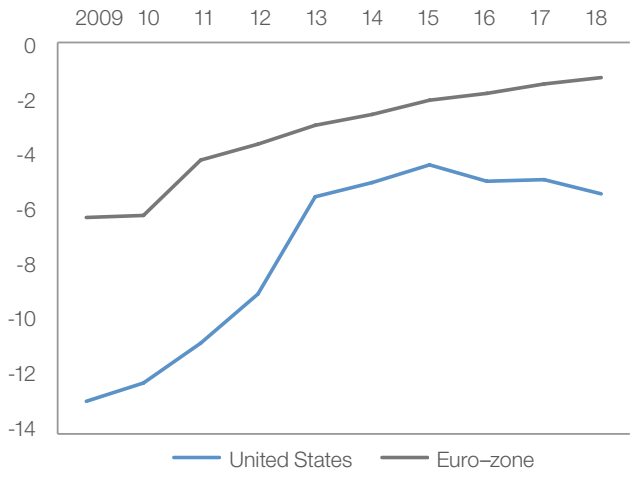
In the wake of the financial crisis, economic policy-making has been predominantly monetary rather than fiscal. Unorthodox countercyclical policies such as quantitative easing – large-scale purchases of government bonds by central banks – have evolved into enduring features of economic policy frameworks. And although evidence points to positive impacts on growth and employment,[14] quantitative easing has also exacerbated income inequality by boosting returns enjoyed by the owners of financial assets,[15] while workers' real earnings have been growing very slowly.[16]

This is not the only source of concern about exceptional monetary policies. Sustained low interest rates can distort the financial mechanisms that underpin healthy economic activity: they make it unusually cheap for struggling companies to roll over their debts, inhibiting the process of re-allocating resources from inefficient to more innovative parts of the economy. This in turn complicates the process of clearing the debt overhangs that in many countries remains an unresolved legacy of the pre-crisis boom, weighing on growth by diverting income towards debt servicing rather than fresh consumption or investment.

Is it time for the pendulum to swing from monetary to fiscal policy? In the United States, President-elect Trump campaigned on the promise of increased infrastructure spending, and globally there is tentative evidence of a gradual move towards fiscal loosening.[17] This presents its own risks: borrowing costs for governments have been exceptionally low in recent years, but if investors were to re-price risk sharply, the adjustment this would require from high-deficit countries could have significant economic and political consequences. However, it is not only concerns about market responses that shape governments' reluctance to turn to fiscal policy. Policy preferences matter too. In the Eurozone, for example, governments have been slow to respond to repeated exhortations from Mario Draghi, the president of the European Central Bank, to find more space for fiscal loosening.[18] Using Organisation for Economic Co-operation and Development (OECD) data, Figure 1.2 illustrates the divergence of fiscal trends in the United States and Eurozone since 2015.

Beyond monetary policy and fiscal stimulus, productivity growth has also been slow to recover from the crisis. Structural rates of unemployment remain high, particularly among young people in Europe, and the United States

Figure 1.2: Fiscal Balances 2009–2018
General government balance; % of GDP



Source: OECD *Economic Outlook 100 database*

has seen a marked slump in labour participation rates. And in contrast with the pre-crisis era, when China's rapid expansion bolstered overall growth rates, there is no emerging-market game-changer on the horizon.[19] China is in a gradual slowdown as its economy transitions from an investment-led to a consumption-led growth model, and many other emerging markets are undergoing a traumatic adjustment to the end of a commodities super-cycle that underpinned much of their growth so far this century.

In sum, it is difficult to identify routes that will lead back to robust global rates of economic growth. However, growth is now only part of the challenge policy-makers need to address. Concerns over income and wealth distribution are becoming more politically disruptive, and much greater emphasis is needed on the increasing financial insecurity that characterizes many people's lives. As socio-economic outcomes are increasingly determined globally, popular frustration is growing at the inability of national politics to provide stability. Economist Dani Rodrik coined the phrase "the globalization trilemma" to capture his view that, among democracy, national sovereignty and global economic integration, only two are simultaneously compatible – and recent events in Europe and the United States suggest an appetite for rebalancing towards democracy and national sovereignty.

The combination of economic inequality and political polarization threatens to amplify global risks, fraying the social solidarity on which the legitimacy of our economic and political systems rests. New economic systems and policy paradigms are urgently needed to address the sources of popular disenchantment.[20] These could include more effective human capital policies, to enable more people to benefit from skill-biased technological change; better public goods (whether publicly or privately provided) to address the ambitions of the growing middle class around the world; and more responsive governance systems to empower individuals at the local level without sacrificing the many benefits of globalization.

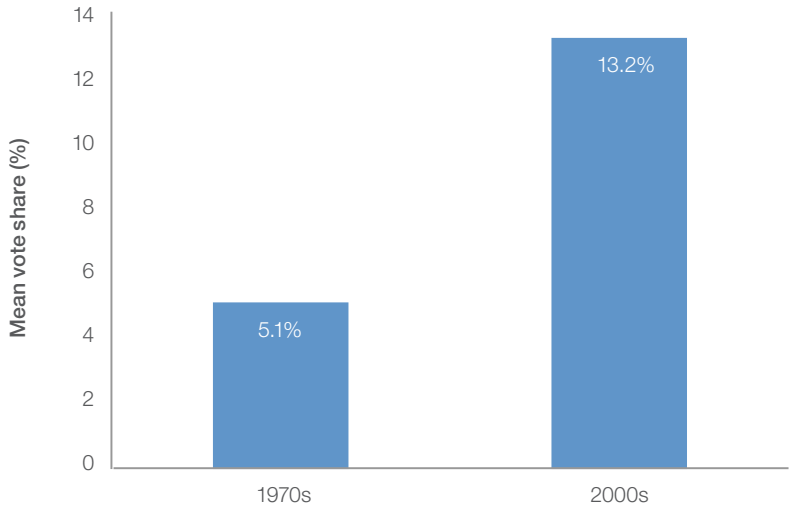
Society: Rebuilding Communities

Issues of identity and culture were central to the two most dramatic Western political results of 2016, in the United Kingdom and the United States. This is part of a broader trend affecting both international and domestic politics. Across the European Union, parties stressing national sovereignty and/or values have prospered,[21] boosted in part by migration flows that GRPS respondents continue to point to as a major geopolitical risk. Outside the European Union, polarization in Turkey has deepened since 2010,[22] while Russia has been expressing its national political identity in increasingly assertive foreign policy stances.[23] Globally, politics is increasingly defined by the rise of charismatic "strongman" national politicians and emotive political debate: "post-truth" was the Oxford English Dictionary's word of the year.[24]

In the latest GRPS, respondents ranked "increasing polarization" as the third most important trend for the next 10 years – it was cited by 31% of respondents, with "increasing national sentiment" cited by 14%. The survey recorded an increase in the perceived impact of "failure of national governance" but, perhaps surprisingly, "profound social instability" dropped in the rankings for both perceived likelihood and impact. One possibility is that the global decision-makers who mostly comprise the GRPS panel have not been sufficiently attuned to this risk. Another way of interpreting the GRPS, however, is to focus on the underlying trends rather than the risks. By placing both polarization and intensifying national sentiment among the top five trends (see Table 1.1), GRPS respondents have highlighted long-term patterns that, if they persist, are likely to continue to amplify a range of social and political risks.

In the West, decades of rapid social and economic change have widened generation gaps in values, disrupted traditional patterns of affiliation and community, and eroded the support of mainstream political parties.[25] Early analysis by political scientists Ronald Inglehart and Pippa Norris points to the populism behind the victories of Brexit and President-elect Trump as being driven more by demographics and cultural factors than income inequality:[26] a backlash among older and less-educated voters who "feel that they are being marginalized within their own countries" by changing values in areas such as gender, sexual orientation, race, multiculturalism, environmental protection and international cooperation. Pew research found stark divisions in the self-described values of supporters of President-elect Trump and Democrat candidate Hillary Clinton: for example, 72% of President-elect Trump's supporters described themselves as "traditional", versus 31% of Clinton supporters; other big differences

Figure 1.3: Populist Voting in Europe



Source: Adapted from Inglehart and Norris (2016), drawing on Döring and Manow (2016). Parliaments and government database (ParlGov) 'Elections' dataset.

Note: Vote shares of populist-right parties in national parliamentary and European parliamentary elections in 24 European countries.

included "honor and duty are my core values" (59% vs 35%); "typical American" (72% vs 49%), "feminist" (5% vs 38%) and "supporter of LGBT rights" (24% vs 66%).[27]

Many established political parties are ill-equipped to respond to voters' placing greater emphasis on culture and values, because the parties have shifted towards the centre of the political spectrum and a managerial or technocratic style of politics.[28] They have lost touch with their traditional core constituencies, particularly those with class-based roots.[29] In 2013, political scientist Peter Mair wrote that political parties' failure to engage voters meant democracy was starting to buckle as electorates "are becoming effectively non-sovereign".[30] Events last year suggest that verdict may have been premature. Both the Brexit and President-elect Trump victories featured (1) outsiders to major party politics (2) successfully engaging traditionalist voters with (3) appeals to sovereignty rooted in national identity and pride. Unusually, older voters were in the vanguard of these disruptive movements – and with populations ageing, the pendulum may not swing back towards the younger generation's views for some time.[31]

Dramatic events can have complex effects on the risk landscape. They can trigger new risks or exacerbate existing ones, but they can also open the way to responses that mitigate risks. As many of the West's democracies face up to the growing electoral influence of traditionalist political identities, there are potential gains for social solidarity and democratic legitimacy if processes of political debate and compromise re-connect with the older, less-educated and predominantly male voters who currently feel excluded. However, it will be challenging to find political narratives and policies that can repair decades-long cultural fault-lines while preserving, for example, gender and minority rights. Failure could further undermine social and cultural cohesion: Daron Acemoglu, author with James Robinson of *Why Nations Fail*, has cautioned that current divisions in the United States risk undermining not just the electoral process but the institutions and norms on which it is founded.[32]

Technology: Managing Disruption

Evidence suggests that technological change provides a better explanation than globalization for the industrial decline and deteriorating labour-market prospects that have catalyzed anti-establishment voting in many of the world's advanced economies. Today's world is one in which production, mobility, communication, energy and other systems are changing with unprecedented speed and scope, disrupting everything from employment patterns to social relationships and geopolitical stability. Driven by the convergence between digital, biological and physical technologies, the Fourth Industrial Revolution (4IR) is creating new global risks and exacerbating existing risks.

Perhaps because of the increasing ubiquity of innovative technology, respondents to the GRPS have tended not to include technological risks among the most impactful or the most likely to occur. This can be seen in the comparatively few technological risks that appear in the evolving risk matrix (Figure 2, inner cover). There are possible signs of change, however. The year 2014 was the first in which two technological risks made it into the evolving risk matrix, and this year, although only one is included ("massive incident of data fraud/theft"), another ("large-scale cyberattacks") came sixth in the list of risks most likely to occur in the next 10 years.

According to the economists Michael Hicks and Srikant Devaraj, 86% of manufacturing job losses in the United States between 1997 and 2007 were the result of rising productivity, compared to less than 14% lost because of trade. Most assessments suggest that technology's disruptive effect on labour markets will accelerate across non-manufacturing sectors in the years ahead, as rapid advances in robotics, sensors and machine learning enable capital to replace labour in an expanding range of service-sector job. Estimates of the number of jobs at risk to technological displacement vary: a frequently cited 2013 Oxford Martin School study has suggested that 47% of US jobs were at high risk from automation; in 2016 an OECD

working paper put the figure lower, at 9%.[33] In 2015 a McKinsey study concluded that 45% of the activities that workers do today could already be automated if companies choose to do so.[34] As discussed in Chapter 3.1, respondents to this year's GRPS rate artificial intelligence and robotics as the emerging technology with the greatest potential for negative consequences over the coming decade.

Technology has always created jobs as well as destroying them, but there is evidence that the engine of technological job creation is sputtering. The Oxford Martin School estimates that only 0.5% of today's US workforce is employed in sectors created since 2000, compared with approximately 8% in industries created during the 1980s.[35] Technological change is shifting the distribution of income from labour to capital: according to the OECD, up to 80% of the decline in labour's share of national income between 1990 and 2007 was the result of the impact of technology.[36] At a global level, however, many people are being left behind altogether: more than 4 billion people still lack access to the internet, and more than 1.2 billion people are without even electricity.[37]

We can shape the dynamics of the 4IR. Careful governance can guide the distribution of benefits and impact on global risks, because the evolution of new technologies will be heavily influenced by the social norms, corporate policies, industry standards and regulatory principles being debated and written today.[38] Unfortunately, however, current legal, policy-making and standard-setting institutions tend to move slowly. For example, the US Federal Aviation Authority took eight months to grant Amazon an "experimental airworthiness certificate" to test a particular model of drone, by which time the model was obsolete;[39] Amazon conducted its trials in Canada and the United Kingdom instead. In 2015, the US Food and Drug Administration (FDA) approved an application by AquaBounty Technologies for regulatory approval of genetically modified salmon – an application made in 1995. The salmon still cannot be sold in the United States, pending an update to labelling regulations.[40]

Such regulatory delays can mean social and economic benefits are missed – but when health, the environment and broader social impacts are at stake, a cautiously deliberative approach is prudent. How best to strike this balance is currently causing debate, for example, in efforts to accelerate the regulation of self-driving vehicles.[41] Although populist movements have recently tapped public hostility to globalization more than to technology, there is still the risk of backlash against technological change. For example, public concerns about genetically modified foods have consistently exceeded scientific assessments of the risks associated with them, and concerns about climate change have not precluded public opposition to wind farms.[42]

We are in a highly disruptive phase of technological development, at a time of rising challenges to social cohesion and policy-makers' legitimacy. Given the power of the 4IR to create and exacerbate global risks, the associated governance challenges are both huge and pressing, as further discussed in Part 3. It is critical that policy-makers and other stakeholders – across government, civil society, academia and the media – collaborate to create more agile and adaptive forms of local, national and global governance and risk management.

Geopolitics: Strengthening Cooperation

In a worrying sign of deteriorating commitment to global cooperation, states are stepping back from mechanisms set up to underpin international security through mutual accountability and respect for common norms. For example, 2016 saw Russia, South Africa, Burundi and Gambia withdraw from the International Criminal Court, and China reject the verdict of the international tribunal on the South China Sea. At the time of writing, the incoming US president is considering withdrawal from the recent Joint Comprehensive Plan of Action (Iran nuclear deal) and the Paris Climate Change agreement. The exit of major stakeholders from economic agreements such as the Trans-Pacific Partnership and Trans-Atlantic Trade and Investment Partnership also carries geopolitical significance.

In Syria, the drawn-out nature of the war indicates how the absence of a great-power accord handicaps the United Nations, compounding the difficulties of brokering a settlement to a conflict with multiple stakeholders at global, regional and non-state levels, or even organizing a limited intervention to facilitate humanitarian relief or protect civilians. The death toll among non-combatants – including from chemical weapons – has been met with despairing rhetoric but no effective action to enforce long-standing humanitarian laws and norms.

In parallel to their withdrawal of support for collective solutions, major powers now openly trade accusations of undermining international security or interfering in their domestic politics. For years President Putin has accused the United States of seeking to undermine global stability and Russian sovereignty, and in 2016 the US National Security Agency blamed Russia for interference in the presidential election. Tensions rose between the United States and China over freedom of navigation in the South China Sea and the deployment of US missile defence systems to the Republic of Korea, which led to Beijing warning the United States not to "harm China's strategic security interests".

In response to the general loss of faith in collective security mechanisms, regional powers and smaller nations are increasingly exploring the acquisition of new conventional weapons capabilities, offensive cyber weapons and even nuclear ones. Notwithstanding the normative and practical obstacles confronting a state seeking nuclear capability, political leaders in nuclear and non-nuclear weapons states alike have increasingly made reference to the utility of nuclear weapons in the context of changing threat perceptions and wavering confidence in alliance structures. If this rhetoric turns into policy, it could entail a huge diversion of resources into a new nuclear arms race and a jump in the risk of pre-emptive strikes aimed at preventing an adversary gaining nuclear capability.

In summary, developments in 2016 present numerous reminders that international security requires collective

commitments and investment to define a positive vision, as well as political will to make responsible trade-offs and commit resources (Box 1.1). As technological, demographic and climate pressures intensify the danger of systems failure, competition among world powers and fragmentation of security efforts makes the international system more fragile, placing collective prosperity and survival at risk.

Environment: Accelerating Action

As Figure 2 (inside front cover) illustrates, a cluster of interconnected environment-related risks – including extreme weather events, climate change and water crises – has consistently featured among the top-ranked global risks for the past seven editions of *The Global Risks Report*. Environment-related risks again stand out in this year's global risk landscape (see Figure 3 (inside rear cover), with every risk in the category lying in the higher-impact, higher-likelihood quadrant. Environmental risks are also closely interconnected with other risk categories. Four of the top ten risk interconnections in this year's GRPS involve environmental risks, the most frequently cited of these being the pairing of "water crises" and "failure of climate change mitigation and adaptation".

This shows that ineffective management of the "global commons" – the oceans, atmosphere, and climate system – can have local as well as global consequences. For example, changing weather patterns or water crises can trigger or exacerbate geopolitical and societal risks such as domestic or regional conflict and involuntary migration, particularly in geopolitically fragile areas.

Further progress was made during 2016 in addressing climate and other environmental risks, reflecting firm international resolve on the transition to a low-carbon global economy and on building resilience to climate change:

- The Paris Agreement on climate change entered into force on 4 November 2016; it is now ratified by more than 110 countries;
- a strong signal of support for implementing the Paris Agreement was made by 196 governments, including China, at the Marrakesh Climate Conference in late November 2016;[43]
- the International Civil Aviation Organisation agreed a "market-based measure" that will ensure no net growth in aviation emissions after 2020 – this is significant because international aviation, like shipping, falls outside the scope of the Paris Agreement; and
- also in October, parties to the Montreal Protocol on ozone-depleting substances agreed an important amendment that could help avoid an additional 0.5°C of warming by 2050 through reducing the use of hydrofluorocarbons (HFCs), which have an extremely high global warming potential.[44]

The year 2016 also saw positive empirical evidence that the transition to a low-carbon economy is underway:

Box 1.1: Five Factors Exacerbating Geopolitical Risks

Five factors aggravate the impact on global risks of the current geopolitical atmosphere of rising competition, loss of trust and heightened suspicion:

First, international cooperation is giving way to unilateral or transactional approaches to foreign policy just as a host of issues – such as global growth, debt and climate change – demand urgent collective action. If allowed to fester, such issues could spawn a range of new problems with costs falling disproportionately on fragile communities.

Second, the inter-connected nature of the global system produces cascading risks at the domestic level. In Syria, for example, failures of governance have produced civil conflict, driving migration that transfers economic, social and political pressures into countries already experiencing frustrations with low growth and rising inequality, fuelling radicalization and acts of violence.

Third, a declining sense of trust and mutual good faith in international relations makes it harder to contain the resulting pressures through domestic policy. The current climate of mutual suspicion can exacerbate domestic political tensions through accusations of outside actors interfering to shape popular perceptions via proxy forces, media manipulation or threatening military gestures.

Fourth, technological innovation exacerbates the risk of conflict. A new arms race is developing in weaponized robotics and artificial intelligence. Cyberspace is now a domain of conflict, and the Arctic and deep oceans are being opened up by remote vehicle access; in each case, there is no established system for policing responsible behaviour. Because research and development of "dual-use" technologies takes place largely in the private sector, they can be weaponized by a wider range of state and non-state actors – for example, the self-proclaimed "Islamic State" has used commercial drones to deliver bombs in Syria, and open-source technology could potentially create devastating biological weapons. Existing counter-proliferation methods and institutions cannot prevent the dissemination of technologies that exist in digital form.

Fifth, while risks intersect and technologies develop quickly, too often our institutions for governing international security remain reactive and slow-moving.

– Bloomberg New Energy Finance reported that global investment in renewable energy capacity in 2015 was US$266 billion, more than double the allocations to new coal and gas capacity;[45] and
– the International Energy Agency (IEA) reported that the total generation capacity of renewable energy now exceeds coal-fired power plants for the for first time, and for the past two years greenhouse gas emissions have been de-coupled from economic growth.[46]

However, the pace of change is not yet fast enough. Global greenhouse gas (GHG) emissions are growing, currently by about 52 billion tonnes of CO_2 equivalent per year,[47] even though the share from industrial and energy sources may be peaking as investment and innovation in green technology accelerates (see Box 1.2). The year 2016 is set to be the warmest on the instrumental record according to provisional analysis by the World Meteorological Organisation.[48] It was the first time the global average temperature was 1 degree Celsius or more above the 1880–1999 average. According to the National Oceanic and Atmospheric Administration, each of the eight months from January through August 2016 were the warmest those months have been in the whole 137 year record.[49]

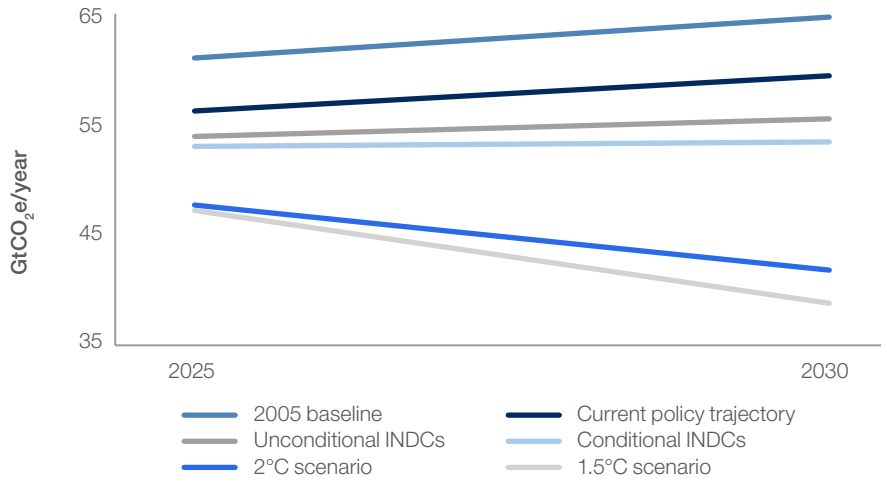
The Emissions Gap Report 2016 from the United Nations Environment Programme (UNEP) shows that even if countries deliver on the commitments – known as Nationally Determined Contributions (NDCs) – that they made in Paris, the world will still warm by 3.0 to 3.2°C.[50] To keep global warming to within 2°C and limit the risk of dangerous climate change, the world will need to reduce emissions by 40% to 70% by 2050 and eliminate them altogether by 2100.[51] While attention will be focused on China, the United States, the European Union, and India – which collectively comprise more than half of global emissions – all countries will need to ratchet up their action in order to limit warming to 2°C.

Increasingly, legal action is being taken against national governments in an attempt to force action on environmental issues. The United Kingdom is being sued for failing to deal with a "national air pollution crisis",[52] and it has also been threatened with legal action if it fails to reduce its greenhouse emissions;[53] a group of teenagers has challenged the US government for not protecting them from climate change;[54] the Netherlands has been ordered by a court to cut its emissions;[55] and Norway is being sued over Arctic drilling plans.[56] Meanwhile, the US Environmental Protection Agency (EPA)'s Clean Power Plan is being challenged in court and has divided the electricity industry: coal miners, some labour unions, and 27 states support the challenge while the renewable energy industry, leading tech firms, and 18 states are supporting the EPA's legislation.[57]

As warming increases, impacts grow. The Arctic sea ice had a record melt in 2016 and the Great Barrier Reef had an unprecedented coral bleaching event, affecting over 700 kilometres of the northern reef.[58] The latest analysis by the UN High Commissioner for Refugees (UNHCR) estimates that, on average, 21.5 million people have been displaced by climate- or weather-related events each year since 2008,[59] and the UN Office for Disaster Risk Reduction (UNISDR) reports that close to 1 billion people were affected by natural disasters in 2015.[60] Communities from Alaska to Fiji and Kiribati have already been relocated or are making plans to do so because the rising sea level threatens their lands.[61] The World Bank forecasts that water stress could cause extreme societal stress in regions such as the Middle East and the Sahel, where the economic impact of water scarcity could put at risk 6% of GDP by 2050.[62] The Bank also forecasts that water availability in cities could decline by as much as two thirds by 2050, as a result of climate change and competition from energy generation and agriculture. The Indian government advised that at least 330 million people were affected by drought in 2016.[63] The confluence of risks around water scarcity, climate change, extreme weather events and involuntary migration remains a potent cocktail and a "risk multiplier", especially in the world economy's more fragile environmental and political contexts.

With power and influence increasingly distributed, however, there is a growing recognition that the response to environmental risks cannot be delivered by international agencies and governments alone. It requires new approaches that take a wider "systems view" of the interconnected challenges, and that involve a larger and more diverse set of actors. Some promising recent examples

Figure 1.4: Projected Global Greenhouse Gas Emissions, 2025–2030



Source: UNEP 2016a.

Notes: (1) The 2005 baseline scenario assumes no additional climate policies put in place from 2005; (2) the two INDC (Intended Nationally Determined Contributions) scenarios assume implementation of commitments made in Paris: "unconditional" assumes only unconditional commitments are implemented, while "conditional" assumes that commitments with conditions attached are also implemented; (3) the 1.5°C and 2°C scenarios represent least expensive paths with a greater than 50% likelihood of limiting warming to below 1.5°C and 2°C respectively.

come from the financial sector: the Financial Stability Board's Taskforce on Climate-related Financial Disclosure is developing recommendations for managing the physical, liability, and transition risks of climate change; rating agencies S&P and Moody's have announced plans to assess the climate risks facing both companies and countries; and investor groups have called for greater disclosure of companies' exposure to climate risks. The Tropical Forest Alliance 2020 also offers the promise of advancing new multi-dimensional approaches to help reduce deforestation from global supply chains, such as the recent Africa Palm Oil Initiative.[64]

Taking a systemic view also implies accounting for new risks that could be created by successful action to address environmental risks. For example, the transition to a low-carbon future will require measures in some economies to absorb potential labour-market impacts. China's announcement in early 2016 that it will reduce its coal and steel sector workforce by 1.8 million (15%) over two years, resettling affected workers in response to industrial overcapacity, may provide a glimpse of what is to come.[65] While most research suggests the shift to clean energy could create a substantial increase in net employment,[66] the overall policy equation is complex and may require new approaches to skills training and retraining, along with measures to facilitate increased labour-force mobility. Ensuring a just transition will be important for societal stability.

Issue-specific and organization-specific silos will need to be dismantled across the public and private sectors throughout the world economy. In their place, new multi-actor alliances and coalitions for action will need to be built, cutting horizontally across traditional boundaries of interest, expertise and nationality. The rise of such multidimensional cooperation to manage our global environmental commons will be challenging in the international context described above, but essential if we are to respond adequately to the structural risks posed by climate change, extreme weather, and water crises.

Box 1.2: Climate Change and the 4IR - by Al Gore, Generation Investment Management

Every day we spew 110 million tons of heat-trapping global warming pollution into our atmosphere. The accumulated amount of all that manmade global warming pollution is trapping as much extra heat energy as would be released by 400,000 Hiroshima-class atomic bombs exploding every single day. All that extra heat energy is disrupting the hydrological cycle, evaporating water vapor from the oceans and leading to stronger storms, more extreme floods, and deeper and longer droughts, declining crop yields, water stresses, the spread of tropical diseases poleward, and refugee crises and political instability, among other problems. Our efforts to solve the climate crisis are a race against time, but the technologies embodying the Fourth Industrial Revolution (4IR), and the implications of these changes for business and society, contain hope for the acceleration of the necessary solutions to the climate crisis.

We are seeing a continuing sharp, exponential decline in the costs of renewable energy, energy efficiency, batteries and storage – and the distribution of technologies that allow for the spread of sustainable agriculture and forestry – giving nations and communities around the world an opportunity to embrace a sustainable future based on a low carbon, hyper-efficient economy. In fact, in many parts of the world, renewable energy is already cheaper than that of fossil fuels. In some developing regions of the world, renewable energy is leapfrogging fossil fuels altogether, much in the same way mobile phones leapfrogged land-line phones.

Sixteen years ago, projections said that by 2010 the world would be able to install 30 gigawatts of wind capacity. In 2015, we installed 14.5 times that amount. Solar energy's price decrease is even steeper and more exciting. Fourteen years ago, projections said that the solar energy market would grow 1 gigawatt per year by 2010 – that goal was exceeded by 17 times over. In 2015, we beat that mark by 58 times and 2016 was on pace to beat that mark 68 times over. In fact, the cost of solar energy has come down 10 percent per year for 30 years.

Similar developments are likely to occur across the board as new developments in electric vehicles, smart grids and micro grids, advanced manufacturing and materials, and other areas continue to accelerate climate action. We are already seeing revolutions unfolding in areas like car sharing, forest monitoring, and data-driven reductions in industrial energy usage.

But it is not just the technologies of the 4IR that are directly making a difference: it is also the transformative operating models inherent within these technologies that contain the seeds for change. The Internet of Things has introduced a world of hyper-connectivity that allows us to approach decision-making in an entirely new manner. Our increased connectivity – between one another and to the material world – enables us to transfer information and materials more efficiently to greater numbers of people. All of this is making the tools we need to solve the greatest challenges we face more effective and more ubiquitous at a previously unseen pace.

We are going to prevail in our collective effort to solve the climate crisis, and it will be in large part due to our increasing ability to mitigate the burning of dirty fossil fuels through the opportunities presented to us by the 4IR.

Endnotes

[1] These problems did not begin with the financial crisis. For example, Russell Dalton (Dalton, 2004) was writing about "the erosion of political support in advanced industrial democracies" in 2004, and one prominent argument about "the hollowing out of Western democracy" looks to the 1990s as a pivotal decade for declining public engagement in politics (Mair, 2013).

[2] Schuman 2016.

[3] World Economic Forum Global Risks Reports, various years.

[4] For evidence of global falling inequality see McCloskey 2016; Pinkovskiy and Sala-i-Martin 2009; Roser 2016.

[5] Roser 2016.

[6] Goldin and Katz 2008; Murphy and Topel 2016.

[7] Gabaix and Landier 2008; Lustig, Syverson, and Van Nieuwerburgh 2011.

[8] Sherwin 1981.

[9] See Darvas and Wolff (2016) on the "jobs polarization" hypothesis, which suggests that technology leads to increased demand for high-skilled and lowest-skilled labour, leading to a hollowing out of the middle class.

[10] Milanovic 2012.

[11] See Eaton et al. 2011; Hoekman 2015; World Economic Forum 2016b.

[12] Sala-i-Martin 2006.

[13] Larrain et al. 2013.

[14] Weale and Wieladek 2014.

[15] Middeldorp 2015.

[16] See the ILO Global Wage Report at http://www.ilo.ch/global/research/global-reports/global-wage-report/2014/lang--en/index.htm

[17] Kahn 2016.

[18] See, for example, Draghi and Constâncio 2016 at https://www.ecb.europa.eu/press/pressconf/2016/html/is160908.en.html

[19] Capital Economics 2016.

[20] Milanovic 2016.

[21] See, for example, the performance of the National Front in France; Alternative for Germany in Germany; Sinn Fein in Ireland; the Freedom Party in Austria; the Party for Freedom in the Netherlands; Law and Justice in Poland; the Danish People's Party in Denmark; Fidesz in Hungary.

[22] Erdogan 2016.

[23] Galeotti and Bowen 2014.

[24] The Economist 2016; Oxford Dictionaries 2016.

[25] Inglehart and Welzel 2005.

[26] Inglehart and Norris 2016.

[27] Pew Research Center 2016.

[28] The Economist Intelligence Unit 2015.

[29] Mair 2013, pp. 37–42.

[30] Mair 2013, p. 2.

[31] Building on his research into intergenerational conflicts in ageing societies (Ahlfeldt, Maennig, and Steenbeck 2016), Gabriel Ahlfeldt notes that a "back-of-the-envelope" calculation suggests that the United Kingdom's Brexit vote would have swung the other way if the electorate had been an average of three years younger, which corresponds to going back in time to the mid-1990s (Ahlfeldt No date).

[32] Acemoglu 2016.

[33] Frey and Osborne 2013.

[34] Chui, Manyika, and Miremadi 2015.

[35] Schwab 2015.

[36] OECD 2012b.

[37] IEA 2016b.

[38] See for example, as shown in the deliberations of the International Summit on Gene Editing in December 2015 (http://www.nationalacademies.org/gene-editing/Gene-Edit-Summit/index.htm) and in the US Federal Automated Vehicles Policy, released in September 2016 (https://www.transportation.gov/AV).

[39] Lavars 2015.

[40] Juma 2016; see also AquaBounty Technologies 2016.

[41] Gonzales 2016.

[42] Gonzales 2016.

[43] United Nations Framework Convention on Climate Change, Marrakech Action Proclamation For Our Climate and Sustainable Development, November 2016, available at https://unfccc.int/files/meetings/marrakech_nov_2016/application/pdf/marrakech_action_proclamation.pdf

[44] UNEP 2016b.

[45] Frankfurt School-UNEP Centre/BNEF 2016.

[46] IEA 2016a.

[47] UNEP 2016a.

[48] WMO (World Meteorological Organisation), *Provisional WMO Statement on the Status of the Global Climate in 2016*, 14 November 2016. http://public.wmo.int/en/media/press-release/provisional-wmo-statement-status-of-global-climate-2016

[49] NOAA 2016.

[50] UNEP 2016a.

[51] IPCC 2014, p. 20.

[52] Kaye 2016.

[53] New Scientist 2015.

[54] Berger 2016.

[55] Nelsen 2015.

[56] Nelsen 2016.

[57] Dlouhy and Harris 2016.

[58] Coral Reef Studies 2016.

[59] IDMC 2016; UNHCR 2016.

[60] CRED 2016.

[61] For information on relocation plans for Alaska, see Malo 2016; for Fiji see Climate Home 2014; for Kiribati see Chapman, 2012.

[62] van der Heijden, Otto, and Maddocks 2015; World Bank 2016.

[63] BBC News 2016.

[64] TFA 2020 2016

[65] Reuters 2016.

[66] OECD 2012a, paragraph 70, p. 38.

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Part 2: Social and Political Challenges

2.1: Western Democracy in Crisis?

In many Western democracies, traditional mainstream political parties are in crisis. They are struggling to respond to rapid changes in the political landscape as voters' disaffection expresses itself in lower turnouts or rising support for previously peripheral movements.[1] The unexpected triumphs in 2016 for the Brexit campaign in the United Kingdom and President-elect Donald Trump's campaign in the United States are the most high profile indicators of a febrile political environment.

But is democracy itself in crisis? Some point out that voters punishing politicians who have failed to represent them adequately is one of the essential virtues of the democratic process. Others argue that the current crisis in mainstream politics goes deeper, fundamentally threatening how politics works. This chapter considers three related reasons to be concerned about the future of democracy: the impacts of rapid economic and technological change; the deepening of social and cultural polarization; and the emergence of "post-truth" political debate.

The chapter then looks at three challenges Western policy-makers will have to try to resolve if they are to tackle these issues successfully: how to make economic growth more inclusive; how to deliver the change voters want while maintaining continuity in systems of government; and how to reconcile growing identity nationalism with diverse societies. The chapter concludes that restoring the health of democracy may prove challenging, but some potential ways forward can be identified.

Rising Support for Anti-Establishment Parties

The recent increase in support and influence enjoyed by anti-establishment, populist political parties and movements in many Western countries is the continuation of a trend with long roots.[2] Anti-establishment populism expresses itself differently in different countries: there are left-wing and right-wing strands, and domestic factors are significant. But there are also common themes: appeals to national sovereignty and criticism that elites have failed to protect electorates from the negative impacts of globalization are threads that run through both left- and right-wing strands. In many cases, there are also appeals to the rights of native citizens, as opposed to immigrants, and the importance of restoring "traditional" values and hierarchies.

The political impact of anti-establishment sentiment has already been dramatic. Most notably, the cluster of anti-elitism, cultural nativism and economic nationalism formed important parts of the winning 2016 campaigns in the United Kingdom (UK) referendum on European Union (EU) membership and both the United States (US) Republican primary and the subsequent presidential election. This cluster has resonated particularly strongly in Europe, where Eurozone and EU problems provide fertile ground for populists calling for a return to national sovereignty. Support for far-right parties has increased in Europe's four largest countries – Germany, the United Kingdom, France and Italy – as well as others, including Austria, Belgium, Denmark, Greece, Hungary, the Netherlands, Poland, Sweden, and Switzerland.[3]

Anti-establishment politicians have not yet won many elections in Europe. Nonetheless, in many countries these movements have already succeeded in shifting the political centre of gravity, forcing mainstream parties to adopt elements of their policy platforms. In some countries – such as Spain and Ireland – they have contributed to a fragmentation of parliamentary forces that has complicated the process of forming stable governments and implementing effective policies. There is even some contested evidence that young people, in particular, are becoming willing to entertain the idea that democracy itself is failing to deliver and to consider non-democratic alternatives.[4]

Three Trends Undermining Democracy

Numerous factors have been suggested as playing a role in weakening democratic legitimacy and effectiveness. While all related, they can be grouped under three main headings.

1. **Rapid economic and technological change**
   Statistics show clearly that globalization and trade have created growth, promoted competitiveness and efficiency,[5] cut poverty and global inequality, and narrowed the gap between emerging economies and the rich world. Overall, global prosperity is at its highest point in a decade.[6] But globalization and trade feature prominently in anti-establishment sentiment in Western democracies because the benefits of growth have been unequally experienced.

   Evidence compiled by economist Branko Milanovic shows that those people between the 75th and 90th percentiles of the global income distribution have been the non-winners from globalization.[7] Meanwhile, the richest have made the biggest gains, especially since the global financial crisis: in the United States, between 2009 and 2012, the incomes of the top 1% grew by more than 31%, compared with less than 0.5% for the remaining 99% of the population (Figure 2.1.1).[8] Middle-class income stagnation is particularly affecting youth: recent research shows that 540 million young people across 25 advanced economies face the prospect of growing up to be poorer than their parents.[9]

   Alongside globalization, technological change has dramatically affected many people's sense of economic security. Traditional manufacturing hubs in advanced economies have been hollowed out by a

combination of labour-saving technology and outsourcing.[10] Technology has historically been a net creator of jobs, but new jobs do not necessarily materialize quickly or in the same locations as jobs that have been displaced: economist Diane Coyle has argued that one of the drivers of current political disaffection in post-industrial regions is that job losses have eroded whole communities.[11]

2. **Deepening social and cultural polarization**
Issues related to national identity, cultural values and ethnic origins have been prominent in the rise of anti-establishment populism. Even in the Nordic countries – affluent, post-industrial knowledge societies, with comparatively homogenous populations and generous welfare models – there is evidence of a backlash against "progressive" changes in social values such as acceptance of same-sex marriage, gender identity and secularism.[12] With the rapid spread of more cosmopolitan and egalitarian attitudes, especially among young people and the educated middle class, those who are older and less educated may feel left behind.[13]

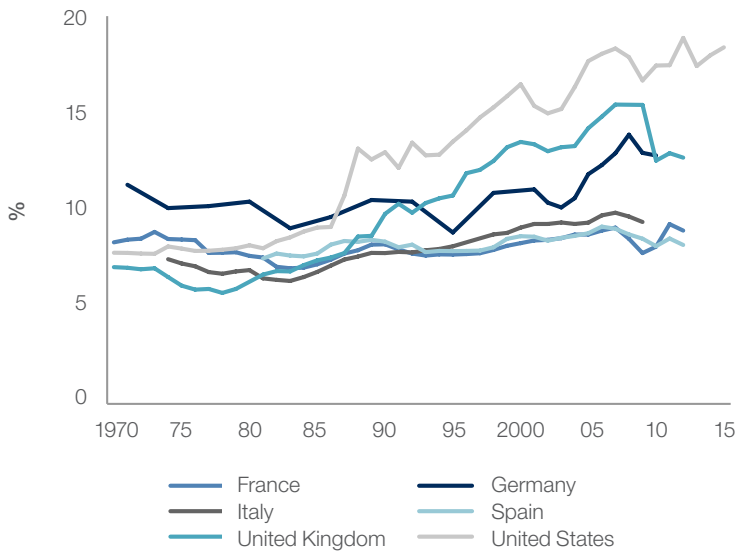
Immigration has proven to be an extremely successful policy issue for anti-establishment populists, providing a common thread for their electoral advances across different countries.[14] However, the links between immigration and populist voting are not straightforward: in the United Kingdom's vote on EU membership, for instance, areas with more immigrants were more likely to support remaining in the European Union.[15] One possible explanation is that what matters to the voters is not so much absolute levels of immigration but rates of change.[16] Another is that voters are focusing on immigration policy for a complex range of reasons: to bolster national sovereignty in a globalized world;[17] to reject the deep cultural changes of recent decades; or to express anger at mainstream politicians for breaking clear promises.[18]

3. **Post-truth political debate**
The cultural polarization of democratic societies has been exacerbated by profound changes in the way news and information is produced, distributed and shared (Box 2.1.1). The aftermath of the US presidential election featured a prominent debate about "fake news".[19] The Oxford English Dictionary chose as its word of the year "post-truth", defined as "denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief".[20]

Free speech and the lively contest of ideas are a fundamental part of the democratic process, but they depend on all participants accepting each other's good faith and a shared set of underlying facts. Historically, relatively small numbers of media outlets provided a widely trusted common foundation for national debates. Increasingly, however, the media landscape is characterized by fragmentation, antagonism and mistrust, with individuals tending to segregate themselves according to their values and beliefs. Online "echo chambers" reinforce rather than challenge people's existing biases, making it easier for misinformation to spread.[21]

Companies that run social media platforms face a commercial incentive to ensure that their users are presented with content with which they are more likely to engage – which, in political terms, implies presenting content with which they are likely to agree.[22] If the resulting emergence of self-reinforcing communities of like-minded people undermines the health of democracy, it raises serious questions related to market capitalism reform, an issue discussed in Part 1 of this *Report*.

Figure 2.1.1: Income Share of the Top 1 % , 1975–2015



Source: The World Wealth and Income Database (http://www.wid.world/#Database).

Three Strategies to Improve Democracy

There is no consensus on what needs to be done to strengthen democratic processes, but three dilemmas can be identified as particularly significant.

1. **Generating more inclusive growth**
The availability of good, well-paying jobs is critical to persuading people that the economic system works for them. Evidence shows that there is no trade-off in principle between promoting social inclusion and competitiveness: growth and equity can go together.[23] Governments can, in theory, deploy various tools, policies and

Box 2.1.1: Social Media and the Distortion of Information - by Walter Quattrociocchi, Northeastern University

Social media can liberate, inform, engage, mobilize, and encourage innovation and democracy. However, social media has also changed the way we get informed and form our opinions, with troubling results. According to one recent estimate,[1] approximately 63% of users acquire their news from social media. But news sourced in this way is subject to the same dynamics as other forms of online content, such as selfies and cat photos. It is the most popular content that spreads, regardless of its factual accuracy.

As a result of disintermediated access to information and algorithms used in content promotion, communication has become increasingly personalized, both in the way messages are framed and how they are shared across social networks. Recent studies show that, online, we seek information that supports existing viewpoints and predominantly engage with communities of like-minded people, leading to the problem of confirmation bias.[2]

Online discussion negatively influences users' emotions and intensifies polarization,[3] creating "echo chambers" – closed, mostly non-interacting communities with different narratives, where beliefs become amplified or reinforced. With users on social media aiming to maximize the number of likes, information is frequently oversimplified. The combination of simplification and segregation provides a fertile environment for the diffusion and persistence of unsubstantiated rumours.[4]

Misinformation has always represented a political, social and economic risk. Social media's power to misinform, manipulate and distort public opinion has become severe. Experimental evidence shows that confirmatory information is accepted even if it contains deliberately false claims, while dissenting information is mainly ignored or might even increase group polarization.[5]

This evidence suggests a real possibility that public opinion can be intentionally distorted by exploiting information overload and confirmation bias, with significant political, social and economic consequences. Strategies for mitigation remain uncertain.[6] Google has proposed trying to correct false claims by marking information as fact-checked; but confirmation bias might simply result in the claim of fact-checking being discounted. The problem behind misinformation is polarization – hence, we need to create synergies among institutions, scholars and communicators to reframe and smooth contrast in the information system.

Notes
[1] Newman, Levy, and Nielsen 2015.
[2] Quattrociocchi, Scala, and Sunstein 2016; Del Vicario et al. 2016.
[3] Zollo et al. 2015; Sunstein 2002.
[4] Mocanu et al. 2015.
[5] Quattrociocchi, Scala, and Sunstein 2016.
[6] Ciampaglia et al. 2015.

institutions to make growth more inclusive. However, in practice, the current environment presents some serious challenges.

Technological change is diminishing the contribution of labour to GDP growth, as machines become more able to do a wider range of work. One study predicts that 47% of US jobs are at risk of automation,[24] affecting over 80% of low-income workers.[25] New technology has also historically increased labour productivity and created new and better jobs – but as machines become better at cognitive as well as physical tasks, there is significant uncertainty about the future of job creation.

Technology is also contributing to the changing nature of work, with secure and predictable jobs giving way to more sporadic, short-term self-employment.[26] Research suggests that the number of people in "alternative work arrangements" increased faster than overall employment between 2005 and 2015.[27] The rise of the "gig economy" threatens the stability of income people need to plan long-term investments such as home ownership and savings for old age. As discussed in Chapter 2.3, it also undermines social insurance schemes that are commonly linked to formal employment.

Populist movements tend to focus blame for job losses on globalization rather than technology, but evidence points to technology being much the bigger factor. As shown by Figure 2.1.2, manufacturing in the United States has not decreased: the country is producing as much as it ever has, only with fewer workers. In the United Kingdom, the share of manufacturing in the economy has decreased – but the manufacturing that remains is higher value,[28] and cross-border services have massively expanded in parallel. Less openness is presented as a simple solution, but it would likely create more problems than it solves: trade barriers intended to protect local workers could, for example, cause job losses by increasing the cost of inputs for high value added companies.

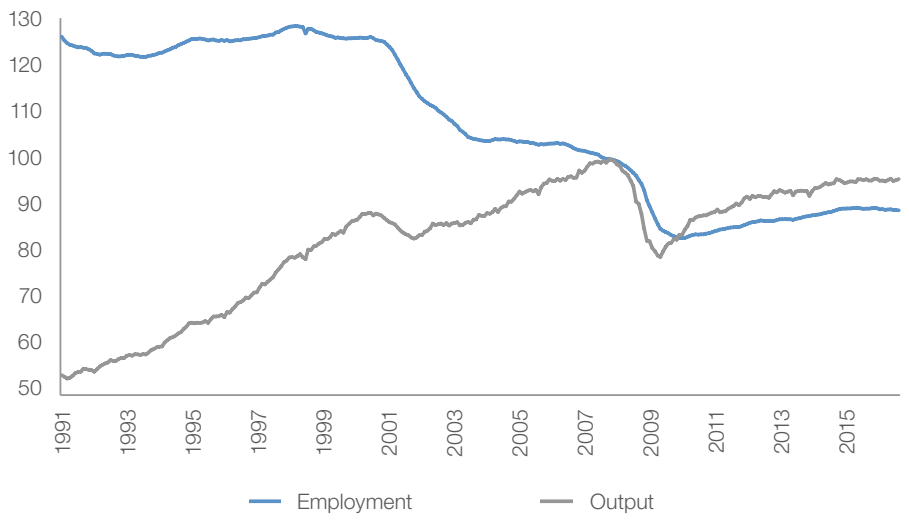
Rather than seeking to reduce globalized trade flows, governments will ultimately need to work out a viable political offer for those negatively impacted. How best to support displaced workers is a complex problem that requires political will to tackle.[29] In particular, an overhaul of labour regulations and employment contracts is likely to be needed to prevent gig economy workers from being left out of existing welfare schemes, and to ensure that governments continue to receive the contributions they need to maintain them.[30]

2. **Maintaining continuity in government while accelerating change**
The economic policies of historically mainstream political parties from the left and the right have converged in recent decades.[31] This has enabled once-fringe movements to rise by portraying the established parties as part of the same technocratic political class, focused on self-enrichment while the institutions of government are allowed to fail. Populist movements call for bold, dramatic action; when moderates point to public debt and overstretched monetary policy as constraining room for manoeuvre, they can be portrayed as patronizing.

Rebuilding public trust in the political process and in leaders will be a difficult task. This work needs to start with the recognition that some valid concerns underlie the rise of anti-establishment sentiment. For example, studies have shown that the preferences of constituents in the lowest third of income groups are not reflected in the votes of their representatives, which are instead overwhelmingly skewed toward the wealthy.[32] Other studies demonstrate the extent to which the "revolving door" between government and business drives growing inequality. [33]

The challenge is to deliver the short-term change voters demand, while also reforming institutions in a way that maintains the continuity of government and established checks and balances. Arguably, the US election result demonstrated a paradox: voters who responded to candidate Donald Trump's "drain the swamp" message often also expressed reservations about his personal suitability for the presidency, implying that they trusted the existing system to be robust enough protect them from potential excesses even as they voted to shake that system up.[34] Finding the right balance between change and continuity will not be easy.

Figure 2.1.2: US Manufacturing Output and Employment, 1991–2016
Output and employment rebased to 100 in 2007



Sources: U.S. Bureau of Labor Statistics 2016; U.S Board of Governors of the Federal Reserve System 2016.

An increasingly common response to popular disaffection with the political process has been for elected representatives to defer to referendums: the UK vote on EU exit was one of a spate of plebiscites in 2016. However, these are an imperfect solution. Representative democracies have typically evolved mechanisms to protect the rights of minorities from crude majoritarianism, and increased use of direct democracy may upset the balance. Countries that lack a historical tradition of direct democracy may also be more likely to struggle with the question of who should be held accountable for implementing the results of popular votes. Moreover, boiling down complex issues to binary questions is an imperfect substitute for genuinely listening to the nuanced concerns of the electorate. One potential solution could be to make better use of technology in the process of government – not only to deliver services in a faster, more transparent, inclusive and consumer-oriented way, but also to establish a "digital public square" with more direct communication between leaders and people.[35]

3. **Reconciling identity nationalism and multiculturalism**
Ongoing humanitarian challenges will continue to create flows of people – and in countries where fertility rates are declining and numbers of pensioners are growing, immigration will be needed to bring in new workers. However, as with globalization, the overall economic benefits brought by immigration are not felt by all sections of society. And immigration creates cultural tensions: there is a need to allow space for religious tolerance without opening the door to extremism, and a need to encourage the diversity that brings innovation without fostering resentment.

In Western democracies, political parties are the traditional mechanism for resolving competing interests,[36] but the rise of identity nationalism has exposed splits in society that cannot be mapped

against existing party structures. This raises the need to find new ways to reconcile differences in opinion about immigration, encouraging assimilation while avoiding the risk of majorities – which represent the prevailing culture – flexing their muscles in a dangerously destabilising way.

Leaders will need to face up to a debate over how to allocate economic and residential entitlements to economic migrants and refugees. Some countries may want to link these entitlements to cultural assimilation or work, treating native populations and migrants unequally: the latter have to earn the rights that are fundamental to the native population's citizenship. Other countries – this was an important driver of the United Kingdom's Brexit vote – may choose to loosen their international economic ties in order to slow the pace of immigration.

To some extent, the cultural challenges associated with immigration could be tackled by getting better at communicating change:[37] data show that voters will change their views on cultural changes in society if politicians highlight the assimilation already taking place.[38]

Conclusion

There is room for debate about the extent to which the rise of anti-establishment sentiment in Western democracies reflects a threat to the democratic process itself. Nonetheless, there are clear reasons to worry about the health of democracy, and challenges related to cultural polarization and economic dislocation have no straightforward answers. This could be a pivotal moment in political history, and it requires courageous new thinking about how best to manage the relationship between citizens and their elected representatives.

Chapter 2.1 was contributed by Stefan Hall, World Economic Forum, and Ngaire Woods, Blavatnik School of Government, University of Oxford.

Endnotes

[1] See the International IDEA Voter Turnout Database, www.idea.int/data-tools
[2] Inglehart and Norris 2016.
[3] Aisch, Pearce, and Rousseau 2016; The Economist Data Team, 2016.
[4] See Foa and Mounk 2016 in their article "The danger of deconsolidation: The democratic disconnect" in *Journal of Democracy* and the response in the same issue by Inglehart.
[5] Dabla-Norris et al. 2015.
[6] Legatum Institute 2016.
[7] Milanovic 2012.
[8] Saez 2013.
[9] Dobbs et al. 2016.
[10] Dabla-Norris et al. 2015.
[11] Coyle 2016.
[12] See the World Values Survey website, http://www.worldvaluessurvey.org/
[13] Norris 2016.
[14] Halla, Wagner, and Zweimüller 2015.
[15] Travis 2016.
[16] The Economist 2016.
[17] The pro-Brexit campaign was built around the hugely successful slogan "Take Back Control!"
[18] Reeves 2016.
[19] Benton 2016; Waters, Garrahan, and Bradshaw 2016.
[20] Oxford Dictionaries 2016.
[21] Del Vicario et al. 2016.
[22] Del Vicario et al. 2016.
[23] Samans et al. 2017.
[24] Frey and Osborne 2013.
[25] Obama and Council of Economic Advisers. 2016
[26] Hill 2015.
[27] Katz and Krueger 2016.
[28] Lanchester 2016.
[29] Brown 2016.
[30] Kuddo, Robalino, and Weber 2015.
[31] Zakaria 2016.
[32] Cramer 2016.
[33] Abernathy, Konczal, and Milani 2016.
[34] Runciman 2016.
[35] Papacharissi 2019.
[36] Lanchester 2016.
[37] Cramer 2016.
[38] Kaufmann 2016.

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2.2: Fraying Rule of Law and Declining Civic Freedoms: Citizens and Civic Space at Risk

A new era of restricted freedoms and increased governmental control could undermine social, political and economic stability and increase the risk of geopolitical and social conflict.[1] Empowered by sophisticated new technological tools in areas such as surveillance, governments and decision-makers around the world are tightening control over civil society organizations, individuals and other actors.

Over the past 10 years, multiple sources from within and outside the civil society sector have pointed to deteriorating rule of law and declining respect for basic civil and political rights at the global level.[2] New regulations and restrictions are ostensibly intended to protect against increased security threats, but potentially threaten the existence of an open and free society and the stability of the environment in which businesses invest and operate.

Civil society actors have historically been integral to driving progress and innovation in the political, social and economic spheres – by advancing human rights, the rule of law and sustainable development – and they are currently at the forefront of efforts to tackle global challenges such as the migration crisis, implementing the United Nations' Sustainable Development Goals (SDGs), and promoting transparent governance. Closing space for civil society reduces the chances that these challenges will be effectively addressed.

This chapter will explain the current challenges of a closing space for civic freedoms and solid rule of law, casting a light on the triggers and contextual factors that are contributing to the phenomenon. A separate focus on the implications for businesses and society at large is also provided to highlight the medium-to-long term impact of this trend and the issues at stake in the global context of a fraying rule of law.

Analysing the Closing Space for Civic Freedoms

"Closing civil society space" refers to actions by governments and others that, intentionally or otherwise, result in the prevention, limitation or eradication of civil society activities. This is something that can occur for very different reasons. In some cases repressive laws have been introduced in order to reduce dissent and silence opposing voices. In others, civil society freedoms have been unintentionally restricted as a consequence of other democratically agreed policies. This is testament to the fact that the compromise between security and liberty is still a difficult one to tread for many policy-makers. In the current context of heightened security concerns and terrorist threats, many governments have promulgated regulatory frameworks that entail greater scrutiny of all economic and societal actors – but trade-offs between security and the protection of civic freedoms have not always been managed in a balanced way, and some of these measures have had a disproportionate impact on civil society organizations in certain parts of the world.[3]

Closing space is difficult to quantify because restrictions are different in each country and impact each actor in different ways.[4] In some countries, for example, businesses and civil society actors have different reporting requirements – for example, civil society actors may be prohibited from receiving foreign donations, while businesses are encouraged to seek foreign investment.[5] However, civil society organizations, media and corporate actors have all expressed growing concern about the closing of civic space.[6] In 2015, CIVICUS found serious threats to one or more civic freedoms – including the freedom of association, freedom of assembly and freedom of expression – in 109 countries, up from 96 in 2014.[7] Restrictions on press freedom are intensifying around the world, with a range of methods from physical violence to legal intimidation to new laws criminalizing speech being widely used by a number of actors to undermine freedom of expression and free flow of information.[8]

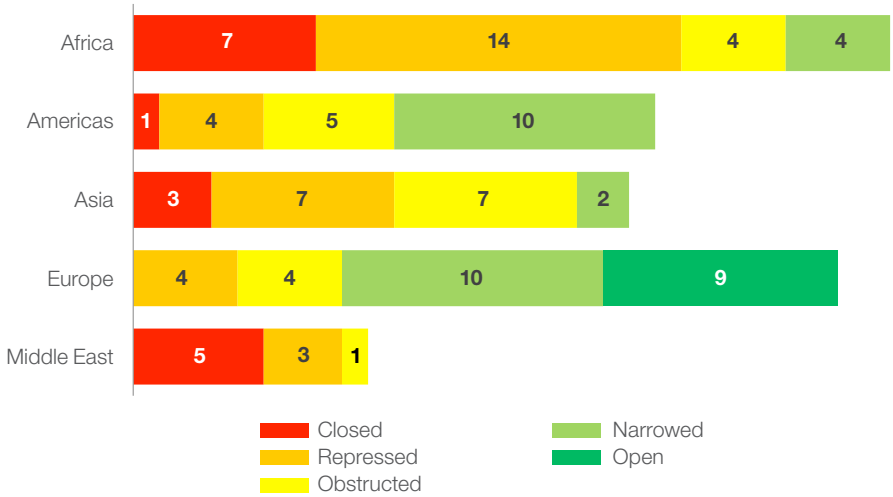
The trend is accelerating and expanding globally, to encompass countries that have traditionally been open and inclusive. According to the CIVICUS Monitor, 3.2 billion people live in countries where the freedoms of expression, association and peaceful assembly are repressed or closed, with only nine countries out of the 104 analysed globally being rated as open in terms of enjoyment of rights and adherence to the rule of law (Figure 2.2.1).[9]

Restrictions affect both organizations and individual citizens, including journalists and media outlets – particularly those who challenge economic and political elites.[10] Methods of restrictions include verbal and physical actions (vilification of civil society groups,[11] crackdowns on protest,[12] violence against individual activists);[13] regulatory measures (burdensome reporting requirements such as on the management of foreign funding);[14] and technological intrusions (e.g. digital rights restrictions).[15] Some organizations have closed down or reduced their operations as a result.[16] Furthermore, in addition to human rights and advocacy organizations, academic, philanthropic and humanitarian entities, as well as journalists, have also been affected by closing civic space.[17]

Triggers and contextual factors

Factors behind the closing space for civil society vary per region, though Table 2.2.1 summarizes some common dynamics. In some cases, security concerns, protectionism and the changing global aid landscape have been used as reasons for reducing dissent. In other cases, restrictions on freedom have been unintended byproducts of well-intentioned security packages. While it is possible to try to distinguish between the trend in authoritarian or semi-authoritarian and democratic countries, worrying trends are seen even in democratic countries.

Figure 2.2.1: Regional Breakdown of CIVICUS Monitor Ratings by Region, October 2016 - Number of countries in each category



Source: CIVICUS Monitor Findings Report, October 2016.

Table 2.2.1: Contextual Factors

Security concerns and counter-terrorism measures	The sensitive geopolitical context, the rise of cyberattacks and major data breaches and hacks, as well as the global insurgency of violent extremism and radicalization have led many countries to adopt security measures and counter-terrorism laws that have increased scrutiny and restrictions on the participation of societal actors, including civil society and individual citizens, sometimes including restrictions on dissenting voices.[1]
Rising nationalism	Civil society actors often challenge decision-makers on issues tied to security and identity, such as the response to terrorism or the refugee crisis, or the treatment of minorities. Nationalist sentiment has fuelled the closing of civic space in an attempt to reduce such criticism.[2] The argument against foreign funding also has nationalistic undercurrents: some non-governmental organizations that take foreign funding have been accused of being unpatriotic or anti-development.[3]
Changing scene of development aid	Developing and emerging countries are often less dependent on foreign aid than they have been in the past, and less tolerant of external influence over the spending of aid money.[4] Claiming ownership of development aid is an important step towards reducing aid dependence – but some governments have used it to exert control over civil society activities in their country.[5]
"Market fundamentalism"	At times the push for economic growth has contributed to restricting the civic space by nurturing in certain geographical contexts the distrust and repression of civil society actors who have criticized business or foreign investors, and who have consequently been labelled "anti-development" or "anti-national interest".[6]

[1] Carothers and Brechenmacher 2014, p. 9; Greenslade 2011; OHCHR 2014b.
[2] Palumbo-Liu 2016; Sokatch 2013.
[3] Such accusations have been made in several countries, including India, Pakistan, and Malawi (see Doane 2016; ICNL 2016a; Jafar 2011, p. 133).
[4] Green 2015.
[5] Rutzen 2015, p. 7.
[6] Doane 2016; Funders' Initiative for Civil Society 2016, p. 9; United Nations Special Rapporteur 2016. In India, the Intelligence Bureau claimed, in a leaked report, that civil society prevents GDP growth by 2–3% per year.

Genuine problems among a subset of civil society actors – such as a lack of transparency and links to terrorism – do exist, but responses are drafted widely enough to affect reliable organizations delivering benefits to society.

The Role of Technology

Technological advances have expanded civic space by providing citizens and organizations with new opportunities to make their voices heard, express their grievances and demand their rights, and innovative ways to hold decision-makers to account. They offer virtual platforms for citizens to engage and mobilize on issues they care about. At the same time, ICT and other technological tools benefit individuals or groups seeking to leverage technology for the spreading of hate, misinformation and extremism, and present challenges for law enforcement and other governmental authorities attempting to monitor terrorist activity.

Technological tools are also being used to increase surveillance and control over citizens, whether for legitimate security concerns or in an attempt to eradicate criticism and opposition. Restricting new opportunities for democratic expression and mobilization,[19] and by consequence the digitally enabled array of civil, political and economic rights (such as the right to work and education; freedom of expression)[20]– just as citizens have become more connected and engaged – creates a potentially explosive situation.

Implications for Citizens and Society

Closing the space for civil society not only reduces the number of actors and operations that are protecting and promoting the common good in society, but it also potentially increases the likelihood and impact of the risks, including:

- **diminishing public trust** in institutions;
- **more resources devoted to national interests over citizens' well-being**, in a context where governments pursue specific agendas without ample prior consultation with societal actors;[21]

- **corruption**, as quantitative and qualitative studies attest to the contribution of civil society organizations in reducing illicit activities;[22,23]
- **polarization of views**, due to misinformation or asymmetry of information across countries and societal groups;[24] and
- **socio-political and economic instability** as discontent around governance systems that are not participatory and accountable manifests as protests.

A world with limited freedoms and closing civil space is additionally deprived of the important economic value contributed by civil society organizations. The economic importance of civil society organizations is under-researched,[25] but some studies find evidence of impact that could be lost as their space to operate shrinks. Back in the 1990s, the Johns Hopkins Comparative Non-profit Sector Project quantified the non-profit sector's economic contribution in the 22 nations examined as $1.1 trillion, with nearly 19 million full-time employees and average expenditure totalling 4.6% of the gross domestic product. These figures are likely to be larger now.[26]

Implications for Business

Civil society actors are increasingly looking to the private sector for support expanding their space to operate.[27] The case for business leaders to promote openness is not always immediately apparent, because shrinking civil society space may not directly impact their core business in the short term. But studies show a long-term link between democratic systems and increases in GDP per capita,[28] and most of the top performers in the World Bank's Doing Business ranking are free countries (Figure 2.2.2).

Societal freedom is economically beneficial for several reasons. Data suggest it reduces corruption,[29] which imposes costs on business: the International Monetary Fund (IMF) puts the annual cost of bribery alone at around US$1.5 to US$2 trillion, nearly 2% of global GDP, and this is only one form of corruption.[30] Additionally, it is often the case that restrictions on civil society represent just the initial sign of more authoritarian systems impacting all economic and societal actors.[31]

Civil society helps to hold economic actors to account for respecting basic rights, promoting competition by creating a more equal playing field. Indeed, in some countries with less open societies, companies are collaborating with civil society actors to facilitate human rights compliance reporting and demonstrate compliance with international standards even if this is not required by domestic legislation. Companies operating in countries where human rights are not respected and civil society is suppressed run a potentially high reputational risk from being associated with environmental or human rights violations in supply chains or at production sites.[32]

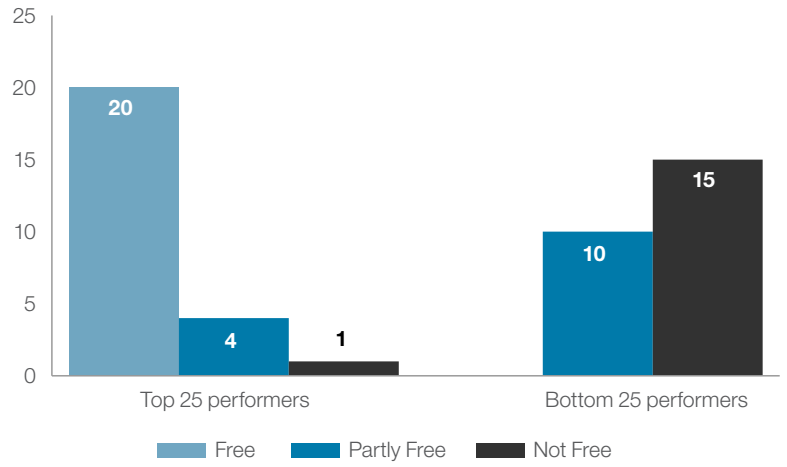
Evidence shows that workforce diversity is good for business,[33] implying that businesses benefit from being located in societies that value diversity. Brain drain fuelled by unstable and corrupt environments means that business loses out on the country's top human potential.[34] From a talent management perspective, it can only be good for companies to be able to freely move their human capital across countries, knowing their staff will not be held back by legal and/or cultural restrictions challenging global corporate diversity policies.[35] Finally, against the backdrop of ongoing pressure on economic and societal actors to deliver on the SDGs through partnerships and cooperation, it is in the interest of corporations to promote an open space where civil society actors can thrive and cross-sectoral partnerships develop. Restrictions to the civic space risks endanger the ability of businesses to achieve their SDG targets.

How Could Business Help to Keep the Civic Space Open?

It is not always straightforward for business leaders to understand the nature of their contribution to promoting open and democratic systems. There are, however, some interesting examples of businesses promoting an inclusive civic space. Business leaders can promote space for civil society "behind the scenes", for example through lobbying in meetings with governmental authorities. At the local level, business associations – which are also affected by closing civic space – can help to coordinate actions such as awareness raising and lobbying the government.[36] In some cases, companies have assisted civil society groups by providing in-kind support, such as meeting space for activists, or indirect support, including quietly resisting discriminatory local practices.[37]

There are also examples of businesses publicly working against specific attempts to limit civil society activities,

Figure 2.2.2: The Top Performers on the World Bank's Doing Business Survey: Mostly Free Countries



Sources: World Bank, *Doing Business*; Freedom House, *Freedom in the World.*

Note: The top-25 and bottom-25 rankings are based on the World Bank 2015 "Distance to Frontier" indicator. The freedom categories are taken from the Freedom House 2015 Freedom in the World report.

as illustrated by technology companies pulling out of countries over internet censorship; diamond companies speaking out against the prosecution of activists; sportswear manufacturers publicly supporting the work of human rights defenders;[38] and food associations bailing out civil society leaders who had been investigating abuses in the food industry.[39]

Considering the complex nature of this challenge, some businesses have preferred to come together in coalitions to collectively raise their voice for the promotion of rights and freedoms in the contexts they operate. Examples include the Open for Business coalition,[40] which supports LGBT (lesbian, gay, bisexual, transgender) diversity across the world.

Increased international solidarity with affected civil society and stronger coalitions of businesses to advance and advocate for human rights promotion are concrete recommendations that have been identified by many organizations as priorities for action.[41]

Conclusions

Despite the global nature of closing civil society space, there is still not much awareness among businesses, decision-makers and a good part of societal actors about this worrisome pattern and the potential risks it can engender: increased social and economic instability, augmented social polarization, more fragile governance, and major detriment to basic civil and political rights that have been gainfully acquired by many countries in the past 50 years. More investment should be put to further study this phenomenon and quantify it in terms of lost economic and social opportunities. With technological innovation creating new opportunities for social inclusion and civic empowerment, time is ripe for all actors to come together and enable an open civic space by collectively taking measures and engaging technology to address this risk effectively.

Chapter 2.2 was contributed by Silvia Magnoni, World Economic Forum, and Kira Youdina, World Economic Forum.

Endnotes

[1] The Economist 2016; Kerry 2015; Sherwood 2015; Stone 2015.

[2] The World Bank definition for "civil society" refers to "*the wide array of non-governmental and not-for-profit organizations that have a presence in public life, expressing the interests and values of their members or others, based on ethical, cultural, political, scientific, religious or philanthropic considerations. Civil Society Organizations (CSOs) therefore refer to a wide of array of organizations: community groups, non-governmental organizations (NGOs), labor unions, indigenous groups, charitable organizations, faith-based organizations, professional associations, and foundations*". See World Bank 2013.

[3] United Nations General Assembly 2016.

[4] United Nations General Assembly 2015.

[5] CIVICUS 2016c, pp. 5, 8.

[6] Assis 2015; CIVICUS 2016a; Roth 2016;Unmüßig 2016. Resolutions regarding enabling civil society space have been adopted at the UN Human Rights Council, and the Officer of the High Commissioner for Human Rights created a handbook on enabling civil society space: http://www.ohchr.org/Documents/AboutUs/CivilSociety/CS_space_UNHRSystem_Guide.pdf

[7] CIVICUS 2016b; Sriskandarajah 2016. Indexes can also be found in USAID's CSO Sustainability Indexes for Sub-Saharan Africa, Asia, Europe and Eurasia, and Middle East and North Africa.

[8] The International Press Institute has recorded increased repression and hostilities towards critical and investigative reporting in the past few years, with journalists being detained and killed, or opposition newspapers suspended/shutdown; see http://www.freemedia.at/

[9] CIVICUS Monitor 2016.

[10] ISHR 2015.

[11] There are many examples of the vilification of or smear campaigns against civil society organisation, painting them as working against the interest of citizens. See Green 2016; Hungary Matters 2015; UN News Centre 2016.

[12] Widespread protest movements, empowered by new technologies, have threatened those in power, thus triggering clampdowns. See Green 2015; Minder 2016; Sherwood 2015.

[13] The organisation Frontline Defenders currently has 220 active cases of actions taken against human rights defenders, including violence. https://www.frontlinedefenders.org/open-cases

[14] Civil society actors do not deny the need for transparency, but regulations have made it impossible for some organisations to function due to an overload of reporting requirements. See ICNL 2016b. Restrictions on receipt of foreign funding have also ensured that organisations have to scale down or stop their activities; see The Economist 2014. The Financial Action Task Force requirements, an anti-terrorism response, has also limited the money that civil society organisations can receive: see the Global NPO Coalition of FATF at http://fatfplatform.org/civil-society-concerns/

[15] Examples include interrupting the internet before or during protests, blocking certain websites, or mass surveillance impinge on digital rights. Numerous cases exist around the world: see Article 19 2015; Mavhinga 2016; Ramdani 2011; RFE/RL 2016; Sutter 2012.

[16] Boon 2015; ICNL 2016b; Sherwood 2015.

[17] As an example, the Scholars at Risk Network, which helps place scholars in universities around the world when they are under threat in their home countries, reports an increase in attacks on scholars: see SARN 2016 at https://www.scholarsatrisk.org/wp-content/uploads/2016/10/SAR-2016-Global-Congress-Report.pdf

[18] It has to be noted that available research on the incidence of NPO (non-profit organisations) abuse for terrorist financing and money laundering is limited and of low quality, and no study has been able to reliably quantify this risk of abuse.

[19] Green 2015; Omidyar 2014; Treisman 2014.

[20] OHCHR 2016.

[21] Oxfam International 2016; SIPRI 2016.

[22] Themudo 2013.

[23] Florini and Simmons 2000; McCoy and Heckel 2001; Ralchev 2004.

[24] Bequelin 2014. Reporting on political issues, corruption and economic trends becomes difficult (see Otis 2013).

[25] Researchers are still debating and clarifying the methodological approaches to defining civil society and measuring its impact (see Enjolras 2015).

[26] Salamon et al. 1999.

[27] CAF 2016.

[28] De Lombaerde and Garay 2006.

[29] Wasow 2011.

[30] IMF 2016.

[31] In Venezuela, for instance, a repressive and populist regime has, over time, imposed its controls on companies, seizing private businesses and farms and restricting the economic influence of major corporate actors. See Forero 2016.

[32] Wilshaw 2015.

[33] Hunt, Layton, and Prince 2015.

[34] Such countries are mirred by corruption and political instability, which is linked to brain drain according to research (see Dimant, Krieger, and Meierrieks 2013Brain drain, for instance, is heavily affecting Russia-based enterprises (see Holodny 2014).

[35] Smedley 2015.

[36] One such example includes the Bishkek Business Club, which lobbied the Kyrgyz government not to accept a "foreign agent" bill that aimed to restrict foreign funding for non-profit organisations. The club argued that the bill went against the Constitution, principles of good governance, and enabling conditions for sustainable economic growth.

[37] In private interviews, activists indicate that they have been able to partner with progressive corporations in some of the most difficult environments. Other examples include businesses standing up for LGBT rights all over the world; see Griffin 2015.

[38] adidas Group 2016.

[39] Lazala 2015.

[40] See https://www.open-for-business.org/

[41] ACT Alliance and CIDSE 2014; intrac for civil society 2014; Mendelson 2015.

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2.3: The Future of Social Protection Systems

Social protection systems consist of policies and programmes designed to reduce poverty and vulnerability by helping individuals manage key economic and social risks, such as unemployment, exclusion, sickness, disability and old age. Although individuals bore virtually all risk for their own financial well-being during the First Industrial Revolution (beginning in 1784), the introduction of social protections and risk-sharing among individuals, employers and governments became increasingly prevalent in the developed world over the course of the Second (beginning in 1870) and Third (1969) Industrial Revolutions.

The Fourth Industrial Revolution is threatening to bring this evolution full circle: severely underfunded state social systems are at a breaking point, employers are backing away from traditional employment models and social protection contributions, and individuals once again are shouldering a larger share of the risks. As longevity trends continue to increase and the threat of the automation of jobs becomes very real, the sharing of this risk needs careful rebalancing in order to minimize potential human suffering.

The Future of Work and Other Challenges Impacting Social Protection

The Fourth Industrial Revolution is fundamentally changing the ways that people work and live in three main ways. First, it is untethering some types of work from a physical location, making it easier to remotely connect workers in one region or country to jobs in another – but also making it less clear which set of employment laws and taxes apply, creating greater global competition for workers, potentially weakening employment protections and draining public social protection coffers.

Second, human labour is being displaced by automation, robotics and artificial intelligence. Opinions differ on the extent of what is possible: Frey and Osborne's (2013) study found that 47% of US employment is at high risk of being automated over the next two decades,[1] while a 2016 study of 21 Organisation for Economic Co-operation and Development (OECD) countries, using a different methodology, concluded that only 9% of jobs are automatable.[2] In general, lower-skilled workers are more likely to see their jobs disappear to automation, increasing their vulnerability and exacerbating societal inequality.[3]

Finally, the nature of the contract between employer and employee is changing, at the same time that the move to a sharing and collaborative economy increases the prevalence of jobs that fall outside the standard employment contract model. The shift has some positive implications for workers, as it potentially offers more control over when and whether to work and opportunities to supplement their incomes – renting out a room through Airbnb, for example, or driving part-time for a service such as Uber.

But this shift also has negative implications: it means workers can expect more volatility in their earnings and leaves them without the employment protections enjoyed by "standard" employees. The rise of zero-hour contracts is one manifestation of this change. Some governments, such as the government of New Zealand, have already banned their use. New employment models also hinder the collection of taxes from both employer and worker, reducing the amount governments have available to fund social protections (see Box 2.3.1).

These three transformations are coinciding with four seismic challenges. First, demographic pressures are further straining formal and informal safety nets. The OECD expects old-age dependency ratios in member countries to double by 2075 as populations age and birth rates fall.[4]

Box 2.3.1: The "Nonstandard Worker": A Working Definition

Although there is no agreed-upon definition of a "nonstandard worker", making it difficult to track and compare numbers globally, the International Labour Organization reports that a vast number of individuals participate in nonstandard work arrangements of one kind or another: one-fifth of China's workforce holds "temporary" jobs; roughly 11% of the workforce in the OECD countries is in temporary employment; and a significant proportion of the workforce in emerging economies such as the Philippines (42%) and Vietnam (68%) have non-agricultural informal jobs without basic social or legal protections or employment benefits.[1]

Note

[1] See George and Chattopadhyay 2015.

Although this is primarily a problem in the developed world, China's elderly population is projected to almost double by 2030, and its fertility rate has dropped from 5.7 in 1969 to 1.6 today.[5] The result will be a tripling of China's elderly dependency ratio by 2050.[6] The UN expects improvements in longevity and advances in healthcare treatments to double aggregate expenses of the elderly by 2050.[7] These factors put intense pressure on pension and healthcare systems, and are spurring countries to increase retirement ages and encourage older workers to remain economically active for longer.

Second, persistently low interest rates are eating into pension value and exacerbating the funding gap. Chile's pension system, for example, currently pays a replacement income of less than 42% for most retirees, while longevity has increased by almost 15 years since 1980. By some calculations, Chileans may need to increase their pension contributions to 18% of salary for men and 14% for women just to maintain the status quo.[8] Without such supplements, increased life expectancy could see future generations' pensions reduced by almost half.

Third, mass migration of labour poses challenges for social protection. Migration is generally seen as a net economic positive: the OECD estimated that immigration in 17 OECD countries from 2007 to 2009 added 0.35% to GDP on average (0.46% in the United Kingdom).[9] However, large and sudden inflows of people can put additional and unpredictable strain on social systems and resources. In Europe, for example, the influx of over 1 million migrants in 2015 was more than four times the number in 2014.[10] The United Kingdom's recent Brexit decision has been widely perceived as representing a backlash to the uncontrolled movement of labour. China has started requiring foreign workers to contribute to social security, although the rules on how pension benefits can be "cashed out" remain unclear.

Finally, increasing levels of wealth and income inequality in many countries across the developed and developing world are putting even greater pressure on fragile or inadequate social protections, particularly for vulnerable lower-income groups. In China, the wealthiest 1% of households own a third of the country's wealth, while in India, the top 1% grew its share of the country's wealth from almost 37% in 2000 to 53% in 2016.[11] The share of income going to workers performing low-skill jobs is decreasing: in the United States, it declined from 38% to 23% between 1968 and 2013.[12] Inability to address these challenges adequately through social security systems could have explosive impacts on social stability (Box 2.3.2).

Box 2.3.2: Advanced versus Emerging Economies: Differing Challenges and Opportunities

Advanced and emerging economies face different challenges and opportunities for developing social protections that support economic growth and social stability in the context of the Fourth Industrial Revolution.

Advanced economies have had the resources to create layered social safety nets, with costs shared across individuals, employers and government, resulting in many more people than in the developing world enjoying some level of protection today. For example, the US Social Security programme, funded by employers and workers, was providing benefits to 60 million people at the end of 2015, while Medicare and Medicaid covered healthcare for 55 million. But such programmes were not designed for the extreme demographic shifts, chronic healthcare challenges, and the effects of the Fourth Industrial Revolution that are reshaping societies. Advanced economies face the challenge of reforming them without incurring a crippling debt burden.

Many emerging market economies arguably have an opportunity to avoid these pitfalls, potentially leapfrogging their wealthier neighbours by formulating sustainable social protection systems that are responsive to the risks of the Fourth Industrial Revolution. Brazil, for example, has implemented the largest cash transfer programme in the world, the Bolsa Familia, which today reaches 55 million of its poorest citizens, costs 30% less per person than more traditional aid programmes, and has helped lift 36 million people out of extreme poverty.[1]

Nonetheless, the varying demographic profiles of growth economies pose different challenges. Asia Pacific is the world's fastest ageing region, with a 71% increase in the number of people aged 65 years and above projected by 2030. Singapore's elderly population will rise from 11% to 20% in the next 15 years; in France, the same shift took 49 years. A rapidly contracting workforce and reallocation of resources towards elderly healthcare weakens these economies' fiscal position and erodes the adequacy and sustainability of pension and social security systems.[2]

Conversely, India has significant potential to reap a demographic dividend, but its limited capacity to create employment poses a serious challenge: between 1991 and 2013 the size of the working-age population increased by 300 million, yet the number of employed only increased by 140 million.[3] By 2017, a staggering 93% of Indians will hold jobs without social security benefits.[4] Solutions are being sought, as the government launches three mega social security schemes – accident coverage, life insurance and pensions.

Sub-Saharan Africa is growing faster than any other region, with an average birth rate of five to seven children per mother and little effective birth control.[5] This scale of growth undermines efforts to reduce poverty or to create jobs, and youth unemployment is high – 50% in South Africa. The ability of nations in Sub-Saharan Africa to create sustainable safety nets will require both political will and economic activity sufficient to create the necessary resources.

Notes
[1] Tepperman 2016.
[2] Marsh & McLennan Companies' APRC 2016.
[3] UNDP 2016.
[4] Waghmare 2016.
[5] UNICEF 2014.

New Social Protection Systems: A Whole-of-Life Approach

New systems will need to address gaps in social protection across typical life events including periods of education, raising families, work including career gaps, retirement, and later elder care (see Figure 2.3.1). Systems will need to provide sufficient *flexibility* to support individuals following substantially different life and career paths while maintaining some inter-group equity, and bolster individual *resilience*.

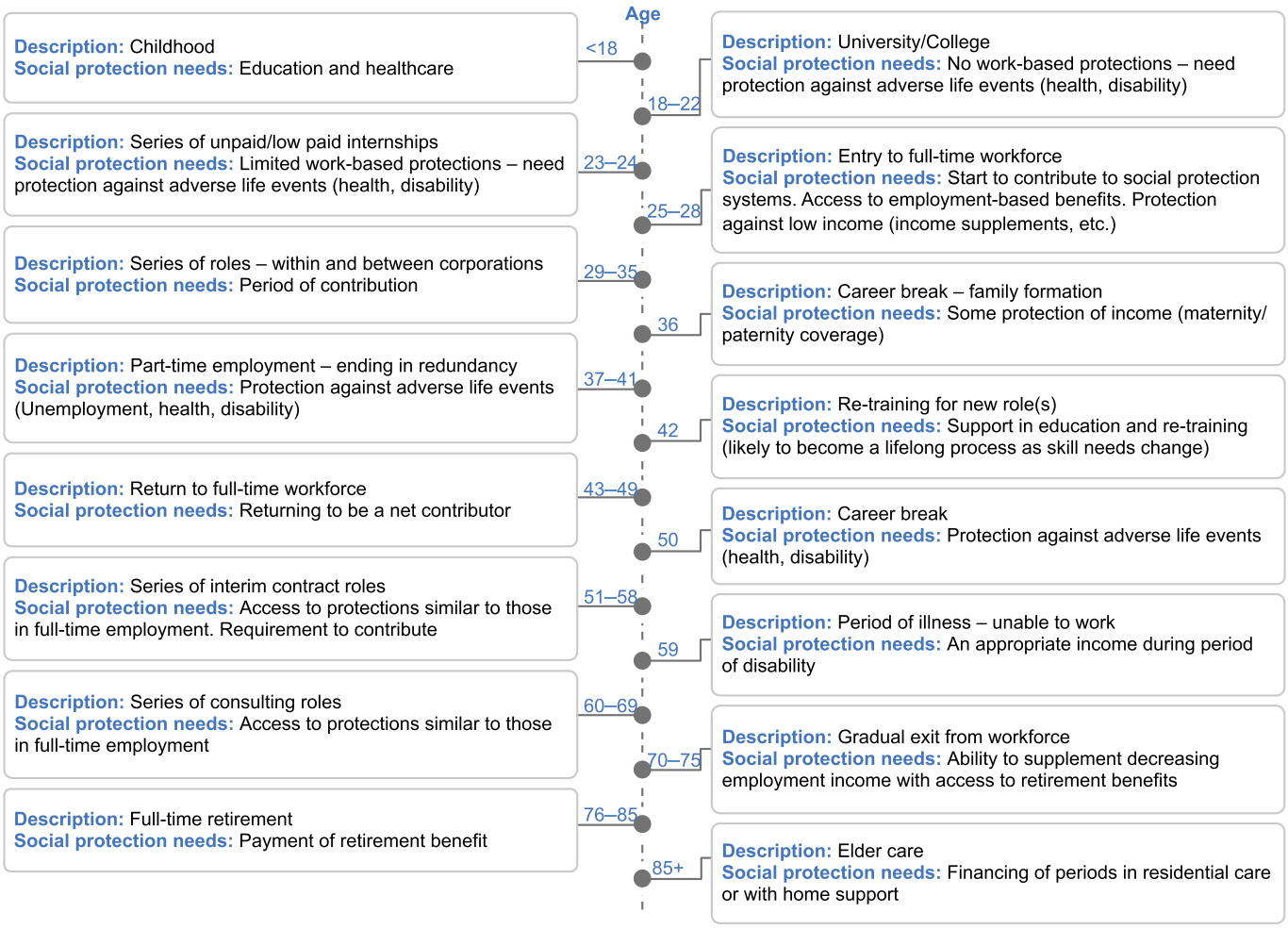
A sustainable social protection system needs to address the changes and challenges described above, ensuring fair payments from employees and employers during times of earning to fund payments that ensure appropriate income support when earnings are not possible. New social protection systems could include a range of approaches, with selected innovations set out below.

1. ***Untethering health and income protection from individual employers or jobs***
   Intermittent, part-time and informal employment or self-employment, with frequent career changes, is becoming the norm in developed as well as developing economies,[13] but most pension systems are still built on the model of continued employment throughout life.[14] Health benefits are provided irrespective of employment in most European nations and Canada, but continue to be largely tied to employment in the United States.

   Potential responses include *creating portable health and pension plans* to maintain coverage as workers move geographically and between employers, or between periods of formal employment – by an employer – and periods of unemployment or self-employment; and *ensuring that risk and responsibility for social protection continue to be shared by the state, employer and employee*. Employers' contributions to funding social protections could be recast to benefit society as a whole rather than their employees only.

2. ***Revamping pension models in line with the new realities of work and ageing***
   Typically, pension systems, whether state or occupational, are diminishing in value because of worsening tax concessions, a lower interest-rate environment,

Figure 2.3.1: A Whole-of-Life Approach to Social Protection Needs in the Fourth Industrial Revolution Era



Source: Mercer 2016.

increasing life expectancy, and increasing regulation and complexity. Compounding the problem is the shortened lifespan of companies,[15] which is undermining the sustainability of funds from company-sponsored pension systems.

One potential response is to introduce *simpler and more flexible plans linked to better advice and guidance*. Products need to be more accessible and flexible to accommodate unique retiree needs, providing a secure income and the flexibility to access capital when needed for life events other than retirement. They need to incorporate affordable options that allow individuals to manage longevity and provide better information about the need to finance later life, with robo-advice likely to become the norm.

Another response is for employers to provide *pensions on an opt-out only basis with default asset allocations*, so the default position is that employees' contribution and investment levels should create sufficient income in later life.

3. ***Implementing policies to increase "flexicurity"***
The changing needs of businesses and individuals in the Fourth Industrial Revolution require giving employers access to a flexible labour force while providing individuals with the security of a safety net and active help in securing employment.

One way to do this is to *increase public spending on active labour market policies (ALMPs)* that either reduce the cost of labour or help people find jobs. For example, Denmark brings together more flexible rules for hiring and firing workers with generous guaranteed unemployment benefits, and spends 1.5% of its GDP on active labour market policies to offer guidance, education, or access to a job to all unemployed workers who are looking for one.[16]

Equalizing rights and benefits for employees and self-employed would incentivize entrepreneurship and provide personalized pathways through the social protection system rather than offering distinct protections for different types of labour. A battle around this issue is already underway as, for example, Uber drivers challenge their status as self-employed independent contractors in the UK courts.[17]

4. ***Implementing alternative models of income distribution***
There are an increasing number of proposals for fundamentally new models of income distribution, which do not tie welfare benefits to being out of work. These include a *negative income tax*, in which people earning below a certain threshold receive supplemental pay from the government; *wage supplements*, in which the government makes up the difference between what a person earns and a recognized minimum income; and a *universal basic income* paid to all members of society regardless of their means.[18] Such income distribution systems would make it much easier for people to take on part-time work or intermittent work as desired.

Voters in Switzerland recently rejected a proposal for a universal basic income,[19] but the idea is attracting growing interest around the world. The government of Finland is considering a pilot programme that would guarantee citizens a partial basic income whether or not they work.[20] Other recent experiments include a pilot programme funded by UNICEF in eight villages in Madhya Pradesh, India, in which every man, woman and child was provided a monthly payment without conditions for 18 months. Improvements in the pilot villages, compared with "control" villages, were seen in the areas of sanitation, access to drinking water, food sufficiency, number of hours worked, children's nutrition, and enrolment levels in secondary schools, particularly for girls.[21]

5. ***Providing greater support for working into old age***
Increasing longevity combined with reduced pensions means that many people will need to work into later life: retirement will become more of a process than an event, with part-time or self-employment continuing possibly well into one's 80s. Typically, women will be even more financially disadvantaged in retirement than men because women live longer and have accrued lower pensions because of career breaks and unequal pay. Reskilling and lifelong learning opportunities are one policy implication, but social protection systems will also need to be more flexible.

Among the possible responses from government and employers are *providing incentives for deferring retirement, supporting senior job seekers*, and *allowing for partial pension payments while a worker in retirement works part-time*. In Japan, the private sector – hobbled by the country's severe shortage of young workers – is leading the effort to push back retirement, with Honda raising its retirement age to 65, nine years in advance of the government's planned countrywide increase. Japan's government invests in connecting people over 60 to jobs through specially designated job resource centres.[22] The United Kingdom offers government workers the option of increasing their state pension in exchange for deferring retirement, with an increase of almost 6% for each year deferred.[23]

As an ageing workforce brings the challenge of higher disability levels, another response is to *make work compatible with increasing levels of disability*: the EU Labour Force Survey (2011) found that 48% of those reporting a longstanding health problem were aged 55–64, and only 12% were aged 15–24.[24] In Germany, which faces one of the world's most rapidly ageing and shrinking populations, employers such as BMW are designing plants with the physical needs and limitations of older workers in mind.[25] In Japan, Toyota is making work more manageable for older workers by reducing the hours of retired re-hires.

The Time to Act Is Now

As the Fourth Industrial Revolution accelerates, many individuals – including lower-skilled workers more easily displaced by automation,[26] part-time and self-employed workers without access to employer-sponsored protections, and older workers and retirees without sufficient savings or pensions – face a potential crisis.[27] There is an urgent need to develop a comprehensive and interconnected set of options that adapt social protection to new-style employment patterns, reskill workers, and respond to the opportunities and threats posed by increasing longevity.

A failure to take action risks both the deterioration of government finances and the exacerbation of social unrest, especially at this time of slow economic growth and widening inequality. The transition from current to new models will be fragmented and slow, given political and financial challenges, and will require collaboration across all sectors of society – public, private and civil society. That makes it is all the more imperative to begin now.

Chapter 2.3 was contributed by Yvonne Sonsino, Mercer, and Ian Veitch, Zurich Insurance Group.

Endnotes

[1] Frey and Osborne 2013.
[2] Arntz, Gregory, and Zierahn 2016.
[3] Arntz, Gregory, and Zierahn 2016.
[4] OECD 2015, http://www.oecd-ilibrary.org/social-issues-migration-health/pensions-at-a-glance-2015/old-age-dependency-ratio_pension_glance-2015-23-en
[5] See the UN DESA Population Division of the World Population Prospects, the 2015 Revision, at https://esa.un.org/unpd/wpp/Graphs/DemographicProfiles/"?
[6] Zhai 2015.
[7] OECD 2015, http://www.oecd-ilibrary.org/social-issues-migration-health/pensions-at-a-glance-2015/old-age-dependency-ratio_pension_glance-2015-23-en
[8] FIAP 2011.
[9] The Migration Observatory 2016.
[10] Clayton and Holland 2015.
[11] Poddar and Bagchi 2016.
[12] Eden and Gaggl 2014
[13] World Economic Forum 2016, p. 26.
[14] ILO 2015.
[15] Innosight 2012.
[16] Denmark, Official Website.
[17] GMB 2016.
[18] Tanner 2015.
[19] Switzerland, the Federal Council Portal of the Swiss government, https://www.admin.ch/gov/en/start/documentation/votes/20160605/unconditional-basic-income.html
[20] Kela 2016.
[21] SEWA Bharat 2014.
[22] Flynn 2014.
[23] United Kingdom, Gov.UK 2016.
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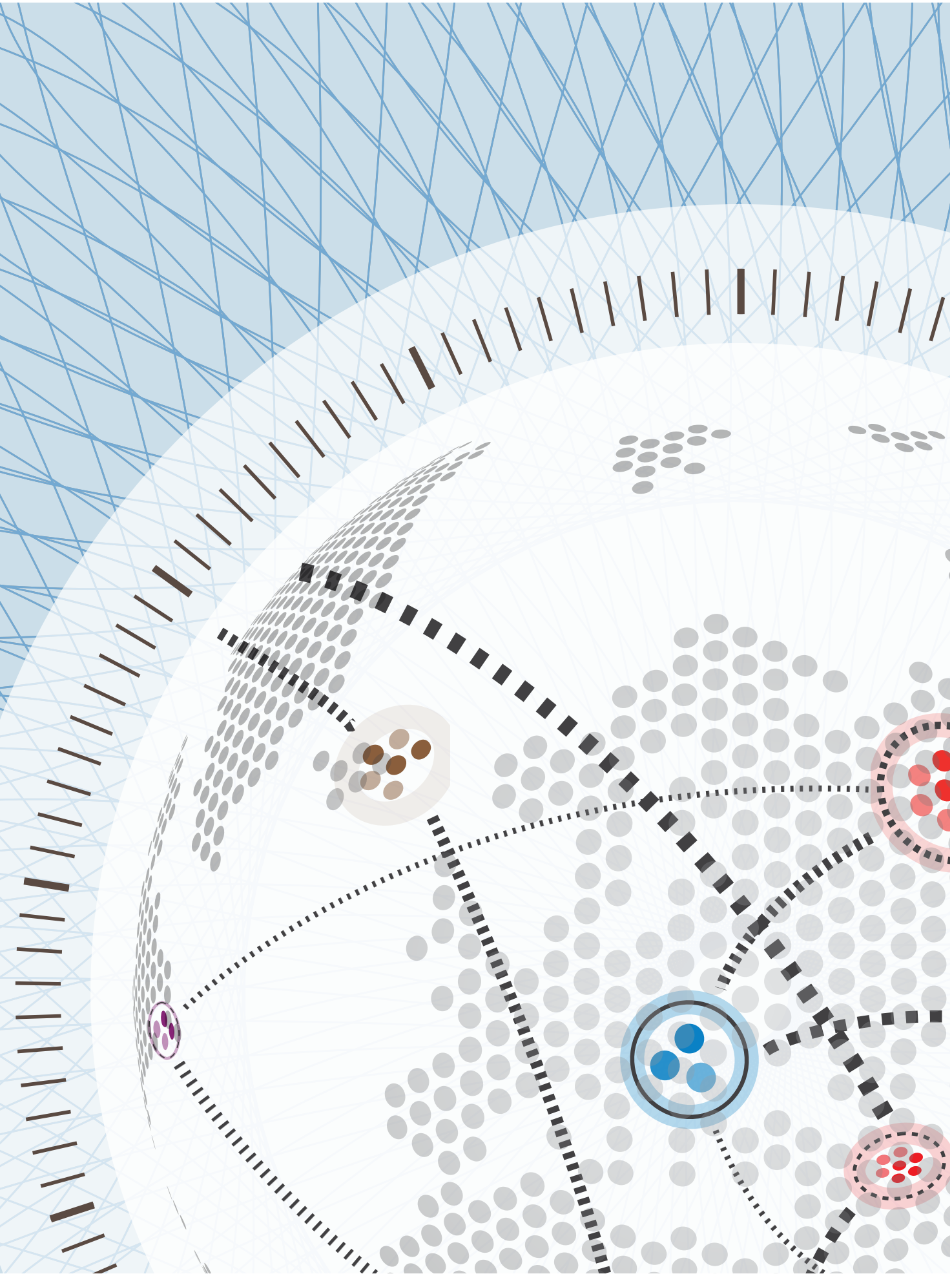


Part 3: Emerging Technologies

3.1: Understanding the Technology Risks Landscape

The emerging technologies of the Fourth Industrial Revolution (4IR) will inevitably transform the world in many ways – some that are desirable and others that are not. The extent to which the benefits are maximized and the risks mitigated will depend on the quality of governance – the rules, norms, standards, incentives, institutions, and other mechanisms that shape the development and deployment of each particular technology.

Too often the debate about emerging technologies takes place at the extremes of possible responses: among those who focus intently on the potential gains and others who dwell on the potential dangers. The real challenge lies in navigating between these two poles: building understanding and awareness of the trade-offs and tensions we face, and making informed decisions about how to proceed. This task is becoming more pressing as technological change deepens and accelerates, and as we become more aware of the lagged societal, political and even geopolitical impact of earlier waves of innovation.

Over the years *The Global Risks Report* has repeatedly highlighted technological risks. In the second edition of the *Report*, as far back as 2006, echoes of current concerns were noted in one of the technology scenarios we considered, in which the "elimination of privacy reduces social cohesion". This was classified as a worst-case scenario, with a likelihood of below 1%. In 2013, the *Report* discussed the risk of "the rapid spread of misinformation", observing that trust was being eroded and that incentives were insufficiently aligned to ensure the maintenance of robust systems of

Table 3.1.1: Twelve Key Emerging Technologies

Technology	Description
3D printing	Advances in additive manufacturing, using a widening range of materials and methods; innovations include 3D bioprinting of organic tissues.
Advanced materials and nanomaterials	Creation of new materials and nanostructures for the development of beneficial material properties, such as thermoelectric efficiency, shape retention and new functionality.
Artificial intelligence and robotics	Development of machines that can substitute for humans, increasingly in tasks associated with thinking, multitasking, and fine motor skills.
Biotechnologies	Innovations in genetic engineering, sequencing and therapeutics, as well as biological-computational interfaces and synthetic biology.
Energy capture, storage and transmission	Breakthroughs in battery and fuel cell efficiency; renewable energy through solar, wind, and tidal technologies; energy distribution through smart grid systems, wireless energy transfer and more.
Blockchain and distributed ledger	Distributed ledger technology based on cryptographic systems that manage, verify and publicly record transaction data; the basis of "cryptocurrencies" such as bitcoin.
Geoengineering	Technological intervention in planetary systems, typically to mitigate effects of climate change by removing carbon dioxide or managing solar radiation.
Ubiquitous linked sensors	Also known as the "Internet of Things". The use of networked sensors to remotely connect, track and manage products, systems, and grids.
Neurotechnologies	Innovations such as smart drugs, neuroimaging, and bioelectronic interfaces that allow for reading, communicating and influencing human brain activity.
New computing technologies	New architectures for computing hardware, such as quantum computing, biological computing or neural network processing, as well as innovative expansion of current computing technologies.
Space technologies	Developments allowing for greater access to and exploration of space, including microsatellites, advanced telescopes, reusable rockets and integrated rocket-jet engines.
Virtual and augmented realities	Next-step interfaces between humans and computers, involving immersive environments, holographic readouts and digitally produced overlays for mixed-reality experiences.

Source: The 12 emerging technologies listed here and included in the GRPS are drawn from World Economic Forum *Handbook on the Fourth Industrial Revolution* (forthcoming, 2017).

quality control or fact-checking. Four years later, this is a growing concern; in Chapter 2.1, the *Report* considers the potential impact of similar trends on the very fabric of democracy.

In 2015, emerging technology was one of the *Report*'s "risks in focus", highlighting, among other things, the ethical dilemmas that exist in areas such as artificial intelligence (AI) and biotechnology.

This year, the Global Risks Perception Survey (GRPS) included a special module on 12 emerging technologies (see Table 3.1.1). The results suggest that respondents are broadly optimistic about the balance of technological risks and benefits. Figure 3.1.1 shows that the average score is much higher for perceived benefits than it is for negative consequences. However, as Figure 3.1.2 makes clear, respondents still identify clear priorities for better governance of emerging technologies.

The remainder of this chapter highlights the particular challenges involved in creating governance regimes for fast-moving technologies, and then summarizes the key results of this year's GRPS special module on emerging technology. The chapter concludes with a discussion of the profound changes that new technologies will entail for businesses and of the cascading effects these changes may have on the global risk landscape.

Governance Dilemmas

How to govern emerging technologies is a complex question. Imposing overly strict restrictions on the development of a technology can delay or prevent potential benefits. But so can continued regulatory uncertainty: investors will be reluctant to back the development of technologies that they fear may later be banned or shunned if the absence of effective governance leads to irresponsible use and a loss of public confidence.

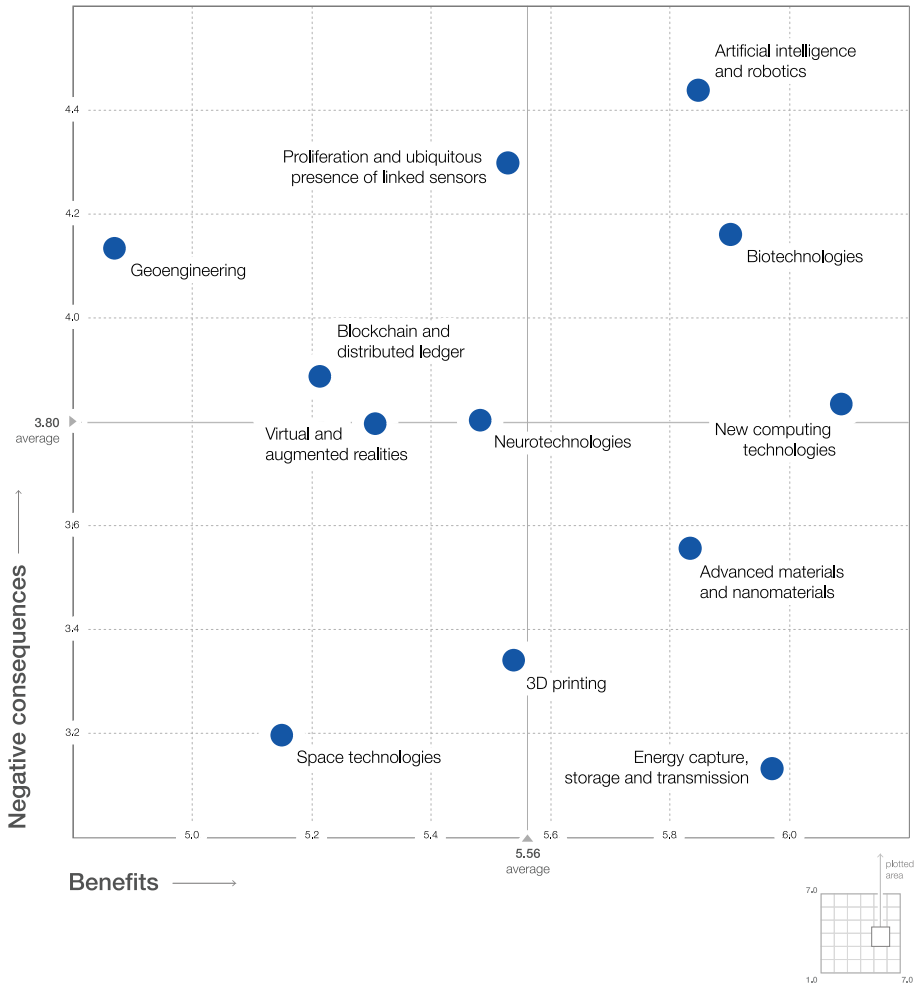
Ideally, governance regimes should be stable, predictable and transparent enough to build confidence among investors, companies and scientists, and should generate a sufficient level of trust and awareness among the general public to enable users to evaluate the significance of early reports of negative consequences. For example, autonomous vehicles will inevitably cause some accidents; whether this leads to calls for bans will depend on whether people trust the mechanisms that have been set up to govern their development.

But governance regimes also need to be agile and adaptive enough to remain relevant in the face of rapid changes in technologies and how they are used. Unexpected new capabilities can rapidly emerge where technologies intersect, or where one technology provides a platform to advance technologies in other areas.[1]

Currently, the governance of emerging technologies is patchy: some are regulated heavily, and others hardly at all because they do not fit under the remit of any existing regulatory body. Mechanisms often do not exist for those responsible for governance to interact with people at the cutting edge of research. Even where insights from the relevant fields can be combined, it can be hard to anticipate what second- or third-order effects might need to be safeguarded against: history shows that the eventual benefits and risks of a new technology can differ widely from expert opinion at the outset.[2]

To the extent that potential trade-offs of a new technology can be anticipated, there is scope for debate about how to approach them. There may be arguments for allowing a technology to advance even if it is expected to create some negative consequences at first, if there is also a reasonable expectation that other innovations will create new ways to mitigate those consequences.

Figure 3.1.1: Perceived Benefits and Negative Consequences of 12 Emerging Technologies



Source: World Economic Forum Global Risks Perception Survey 2016.

Note: See Appendix B for more details on the methodology.

Even if there is widespread desire to restrict the progress of a particular technology – such as lethal autonomous weapons systems – there may be practical difficulties in getting effective governance mechanisms in place before the genie is out of the bottle.

The growing popular awareness of the dilemmas associated with governing new technologies is revealed by media analysis: relevant mentions of such quandaries in major news sources doubled between 2013 and 2016. But which technologies should we be focusing on? In the latest GRPS, we asked respondents to assess 12 technologies on their potential benefits and adverse consequences, public understanding and need for better governance.

Technologies that Need Better Governance

Figure 3.1.1 plots respondents' perceptions of the potential benefits and negative consequences of the 12 technologies included in the GRPS. As noted above, the average score for benefits is much higher than it is for adverse consequences,[3] suggesting that respondents are optimistic about the net impact of emerging technologies as a whole.[4] Technologies considered to have above-average risks and below-average benefits, in the upper left quadrant of the figure, tended to be those where respondents felt least confident of their own assessments and also least confident of the public's understanding.

Three technologies occupy the upper-right quadrant of Figure 3.1.1, indicating an above-average score for both potential benefits and risks: *artificial intelligence (AI) and robotics, biotechnologies*, and *new computing technologies*. Analysis of media coverage resonates with respondents' high ranking for the risk associated with AI: from 2013 to 2016 there was a steady rise in reporting on whether we should fear AI technologies.[5] Respondents also cited artificial intelligence (AI) and robotics most frequently when asked how the 12 emerging technologies exacerbate the five categories of global risk covered by *The Global Risks Report*. As Figure 3.1.2 illustrates, this was seen as the most important driver of risks in the economic, geopolitical and technological categories.

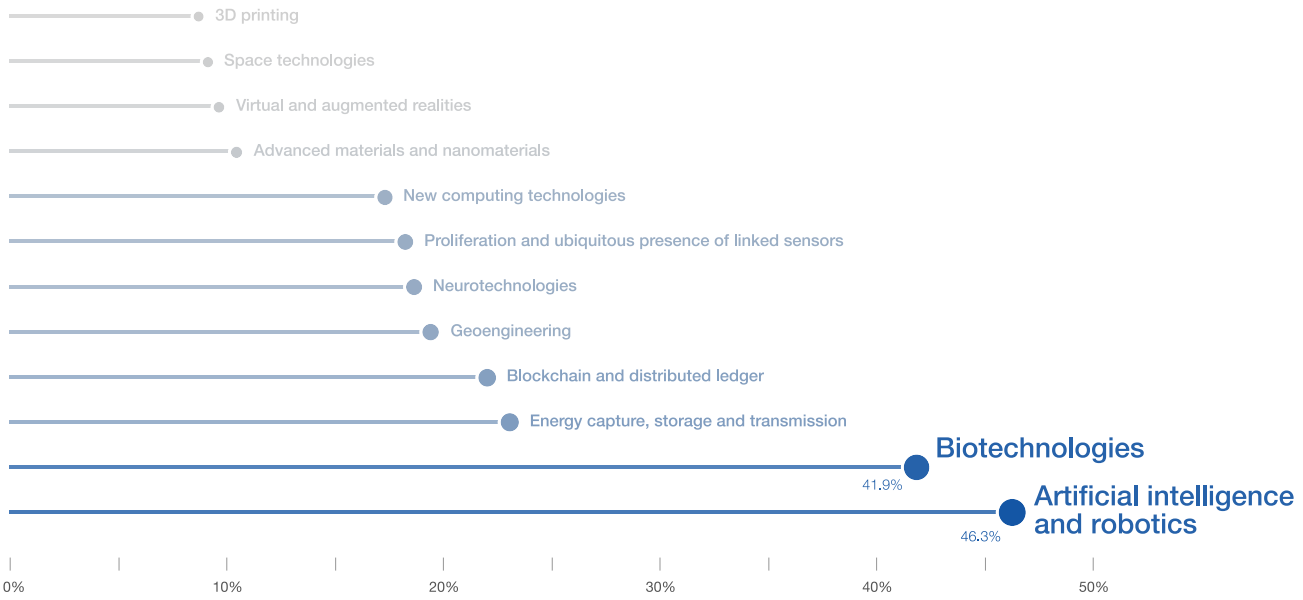
In Figure 3.1.3, two technologies stand out as requiring better governance in the view of GRPS respondents: both *artificial intelligence (AI) and robotics*

Figure 3.1.2: How Emerging Technologies Exacerbate Global Risks

Source: World Economic Forum Global Risks Perception Survey 2016.

Note: Respondents were asked to select the three emerging technologies that they believe will most significantly exacerbate global risks in each category.

Figure 3.1.3: Emerging Technologies Perceived as Needing Better Governance



Source: World Economic Forum Global Risks Perception Survey 2016.

Note: Respondents were asked to select the three emerging technologies that they believe most need better governance. The figure presents the percentage of respondents who selected each technology.

and *biotechnologies* were cited by more than 40% of respondents. These two technologies differ greatly in terms of the current state of their governance.

Biotechnologies, which involve the modification of living organisms for medicinal, agricultural or industrial uses, tend to be highly regulated.[6] Biotech became a global governance issue in 1992 with the Convention on Biological Diversity, now ratified by 196 countries.[7] AI and robotics, meanwhile, are only lightly governed in most parts of the world. As "general purpose technologies", in the words of economic historian Gavin Wright,[8] they have applications in many fields that already have their own governance regimes. For example, where machine learning is used in areas such as online translation, internet search and speech recognition, it comes under governance related to the use of data. Industrial robots are governed by International Organization for Standardization (ISO) standards,[9] while domestic robots are primarily governed by existing product certification regulations. There is increasing debate about the governance of AI given the risks involved, which are further discussed in Chapter 3.2.

The Disruptive Impact of Emerging Technologies

The potential of emerging technologies to disrupt established business models is large and growing. It is tempting to think of technological disruption as involving dramatic moments of transformation, but in many areas disruption due to emerging technologies is already quietly under way, the result of gradual evolution rather than radical change. Consider autonomous vehicles: we are not yet in a world of vehicles that require little or no human intervention, but the technologies that underpin autonomy are increasingly present in our "ordinary" cars.

As the technological changes entailed by the 4IR deepen, so will the strain on many business models. The automotive sector remains a good example. It has been clear for some time that car manufacturers need to plan ahead for a world in which many of the factors that determine current levels of car ownership may no longer be present. Increasing evidence of this planning is now starting to shape commercial decision-making. For example, in December 2016, Volkswagen launched a new "mobility services" venture, MOIA, in recognition of "an ever-stronger trend away from owning a vehicle towards shared mobility as well as mobility on demand".[10]

The deep interconnectedness of global risks means that technological transitions can exert a multiplier effect on the risk landscape. This does not apply only to newly emerging technologies: arguably much of the recent social and political volatility that is discussed in Parts 1 and 2 of this year's *Global Risks Report* reflects, in part at least, the lagged impact of earlier periods of technological change. One obvious channel through which technological change can lead to wider disruption is the labour market, with incomes pushed down and unemployment pushed up in affected sectors and geographical regions. This in turn can lead to disruptive social instability, in line with the GRPS finding this year that the most important interconnection of global risks is the pairing of unemployment and social instability.

Another prism through which to look at the interaction of risks and emerging technologies is that of liability – or, to put it another way, the question of who is left bearing which risks as a result of technological change. There are multiple potential sources of

disruption here. The insurance sector is an obvious example when talking about liability; just as car manufacturers must prepare for a future of driverless vehicles, so the reduction in accidents this future would entail means insurance companies must prepare for plummeting demand for car insurance.[11] But the idea of liability can also be understood more broadly, to include the kind of social structures and institutions discussed in Chapter 2.3 on social protection. Already there are signs of strain in these institutions, such as mounting uncertainty about the rights and responsibilities of workers and employers in the "gig economy". One of the challenges of responding to accelerating technological change in the 4IR will be ensuring that the evolution of our critical social infrastructure keeps pace.

Chapter 3.1 was contributed by Nicholas Davies, World Economic Forum, and Thomas Philbeck, World Economic Forum.

Endnotes

[1] Alford, Keenihan, and McGrail 2012.

[2] Juma 2016.

[3] The overall average response for benefits to emerge from emerging technologies was 5.6, equating to a likelihood of above 55% and below 75%. This contrasts sharply with the average of 3.8 for negative consequences, equating to an assessed likelihood of between 25% and 45%.

[4] It is noteworthy that no single technology was, on average, assessed to present negative consequences at a higher likelihood than its benefits. The technology with the lowest net benefits in this regard was Geoengineering, with the fourth highest assessment of negative consequences overall and the lowest assessment of benefits. At the other end of the scale, the technology with the greatest assessed net benefit was Energy capture, storage and transmission.

[5] Quid analysis performed by the World Economic Forum on key search terms across major news sources, November 2016.

[6] In the United States, the White House Office of Science and Technology Policy issued its first federal framework for biotech regulation in 1986.

[7] United Nations 1992, Convention on Biological Diversity, Article 8.

[8] Wright 2000.

[9] See, for example, ISO 10218-1 (2011) and ISO 10218-2 (2011).

[10] Volkswagen 2016.

[11] KPMG 2015.

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3.2: Assessing the Risk of Artificial Intelligence

Every step forward in artificial intelligence (AI) challenges assumptions about what machines can do. Myriad opportunities for economic benefit have created a stable flow of investment into AI research and development, but with the opportunities come risks to decision-making, security and governance. Increasingly intelligent systems supplanting both blue- and white-collar employees are exposing the fault lines in our economic and social systems and requiring policy-makers to look for measures that will build resilience to the impact of automation.

Leading entrepreneurs and scientists are also concerned about how to engineer intelligent systems as these systems begin implicitly taking on social obligations and responsibilities, and several of them penned an *Open Letter on Research Priorities for Robust and Beneficial Artificial Intelligence* in late 2015.[1] Whether or not we are comfortable with AI may already be moot: more pertinent questions might be whether we can and ought to build trust in systems that can make decisions beyond human oversight that may have irreversible consequences.

Growing Investment, Benefits and Potential Risk

By providing new information and improving decision-making through data-driven strategies, AI could potentially help to solve some of the complex global challenges of the 21st century, from climate change and resource utilization to the impact of population growth and healthcare issues. Start-ups specializing in AI applications received US$2.4 billion in venture capital funding globally in 2015 and more than US$1.5 billion in the first half of 2016.[2] Government programmes and existing technology companies add further billions (Figure 3.2.1). Leading players are not just hiring *from* universities, they are hiring the universities: Amazon, Google and Microsoft have moved to funding professorships and directly acquiring university researchers in the search for competitive advantage.[3]

Machine learning techniques are now revealing valuable patterns in large data sets and adding value to enterprises by tackling problems at a scale beyond human capability. For example, Stanford's computational pathologist (C-Path) has highlighted unnoticed indicators for breast cancer by analysing thousands of cellular features on hundreds of tumour images,[4] while DeepMind increased the power usage efficiency of Alphabet Inc.'s data centres by 15%.[5] AI applications can reduce costs and improve diagnostics with staggering speed and surprising creativity.

The generic term AI covers a wide range of capabilities and potential capabilities. Some serious thinkers fear that AI could one day pose an existential threat: a "superintelligence" might pursue goals that prove not to be aligned with the continued existence of humankind. Such fears relate to "strong" AI or "artificial general intelligence" (AGI), which would be the equivalent of human-level awareness, but which does not yet exist.[6] Current AI applications are forms of "weak" or "narrow" AI or "artificial specialized intelligence" (ASI); they are directed at solving specific problems or taking actions within a limited set of parameters, some of which may be unknown and must be discovered and learned.

Tasks such as trading stocks, writing sports summaries, flying military planes and keeping a car within its lane on the highway are now all within the domain of ASI. As ASI applications expand, so do the risks of these applications operating in unforeseeable ways or outside the control of humans.[7] The 2010 and 2015 stock market "flash crashes" illustrate how ASI applications can have unanticipated real-world impacts, while AlphaGo shows how ASI can surprise human experts with novel but effective tactics (Box 3.2.1). In combination with robotics, AI applications are already affecting employment and shaping risks related to social inequality.[8]

AI has great potential to augment human decision-making by countering cognitive biases and making rapid sense of extremely large data sets: at least one venture capital firm has already appointed an AI application to help determine its financial decisions.[9] Gradually removing human oversight can increase efficiency and is necessary for some applications, such as automated vehicles. However, there are dangers in coming to depend entirely on the decisions of AI systems when we do not fully understand how the systems are making those decisions.[10]

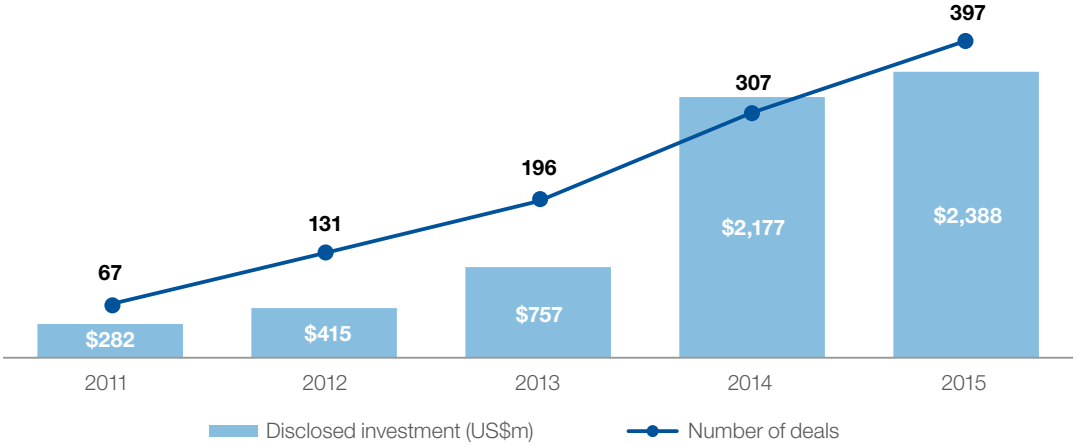
Risks to Decision-Making, Security and Safety

In any complex and chaotic system, including AI systems, potential dangers include mismanagement, design vulnerabilities, accidents and unforeseen occurrences.[11] These pose serious challenges to ensuring the security and safety of individuals, governments and enterprises. It may be tolerable for a bug to cause an AI mobile phone application to freeze or misunderstand a request, for example, but when an AI weapons system or autonomous navigation system encounters a mistake in a line of code, the results could be lethal.

Machine-learning algorithms can also develop their own biases, depending on the data they analyse. For example, an experimental Twitter account run by an AI application ended up being taken down for making socially unacceptable remarks;[12] search engine algorithms have also come under fire for undesirable race-related results.[13] Decision-making that is either fully or partially dependent on AI systems will need to consider management protocols to avoid or remedy such outcomes.

AI systems in the Cloud are of particular concern because of issues of control and governance. Some experts

Figure 3.2.1: Global Financing for AI Start-Ups, 2011–2015



Source: CB Insights 2016.

Box 3.2.1: Artificial Intelligence and the Future of Warfare - by Jean-Marc Rickli, Geneva Centre for Security Policy

One sector that saw the huge disruptive potential of AI from an early stage is the military. The weaponization of AI will represent a paradigm shift in the way wars are fought, with profound consequences for international security and stability. Serious investment in autonomous weapon systems (AWS) began a few years ago; in July 2016 the Pentagon's Defense Science Board published its first study on autonomy, but there is no consensus yet on how to regulate the development of these weapons.

The international community started to debate the emerging technology of lethal autonomous weapons systems (LAWS) in the framework of the United Nations Convention on Conventional Weapon (CCW) in 2014. Yet, so far, states have not agreed on how to proceed. Those calling for a ban on AWS fear that human beings will be removed from the loop, leaving decisions on the use lethal force to machines, with ramifications we do not yet understand.

There are lessons here from non-military applications of AI. Consider the example of AlphaGo, the AI Go-player created by Google's DeepMind division, which in March last year beat the world's second-best human player. Some of AlphaGo's moves puzzled observers, because they did not fit usual human patterns of play. DeepMind CEO Demis Hassabis explained the reason for this difference as follows: "unlike humans, the AlphaGo program aims to maximize the probability of winning rather than optimizing margins". If this binary logic – in which the only thing that matters is winning while the margin of victory is irrelevant – were built into an autonomous weapons system, it would lead to the violation of the principle of proportionality, because the algorithm would see no difference between victories that required it to kill one adversary or 1,000.

Autonomous weapons systems will also have an impact on strategic stability. Since 1945, the global strategic balance has prioritized defensive systems – a priority that has been conducive to stability because it has deterred attacks. However, the strategy of choice for AWS will be based on swarming, in which an adversary's defence system is overwhelmed with a concentrated barrage of coordinated simultaneous attacks. This risks upsetting the global equilibrium by neutralizing the defence systems on which it is founded. This would lead to a very unstable international configuration, encouraging escalation and arms races and the replacement of deterrence by pre-emption.

We may already have passed the tipping point for prohibiting the development of these weapons. An arms race in autonomous weapons systems is very likely in the near future. The international community should tackle this issue with the utmost urgency and seriousness because, once the first fully autonomous weapons are deployed, it will be too late to go back.

propose that robust AI systems should run in a "sandbox" – an experimental space disconnected from external systems – but some cognitive services already depend on their connection to the internet. The AI legal assistant ROSS, for example, must have access to electronically available databases. IBM's Watson accesses electronic journals, delivers its services, and even teaches a university course via the internet.[14] The data extraction program TextRunner is successful precisely because it is left to explore the web and draw its own conclusions unsupervised.[15]

On the other hand, AI can help solve cybersecurity challenges. Currently AI applications are used to spot cyberattacks and potential fraud in internet transactions. Whether AI applications are better at learning to attack or defend will determine whether online systems become more secure or more prone to successful cyberattacks.[16] AI systems are already analysing vast amounts of data from phone applications and wearables; as sensors find their way into our appliances and clothing, maintaining security over our data and our accounts will become an even more crucial priority. In the physical world, AI systems are also being used in surveillance and monitoring – analysing video and sound to spot crime, help with anti-terrorism and report unusual activity.[17] How much they will come to reduce overall privacy is a real concern.

Can AI Be Governed – Now or in the Future?

So far, AI development has occurred in the absence of almost any regulatory environment.[18] As AI systems inhabit more technologies in daily life, calls for regulatory guidelines will increase. But can AI systems be sufficiently governed? Such governance would require multiple layers that include ethical standards, normative expectations of AI applications, implementation scenarios, and assessments of responsibility and accountability for actions taken by or on behalf of an autonomous AI system.

AI research and development presents issues that complicate standard approaches to governance, and can take place outside of traditional institutional frameworks, with both people and machines and in various locations. The developments in AI may not be well understood by policy-makers who do not have specialized knowledge of the field; and they may involve technologies that are not an issue on their own but that collectively present emergent properties that require attention.[19] It would be difficult to regulate such things before they happen, and any unforeseeable consequences or control issues may be beyond governance once they occur (Box 3.2.2).

One option could be to regulate the technologies through which the systems work. For example, in response to the development of automated transportation that will require AI systems, the U.S. Department of Transportation has issued a 116 page policy guide.[20] Although the policy guide does not address AI applications directly, it does put in place guidance frameworks for the developers of automated vehicles in terms of safety, control and testing.

Box 3.2.2: Aligning the Values of Humans and AI Machines - by Stuart Russell, University of California, Berkeley

Few in the field believe that there are intrinsic limits to machine intelligence, and even fewer argue for self-imposed limits. Thus it is prudent to anticipate the possibility that machines will exceed human capabilities, as Alan Turing posited in 1951: "If a machine can think, it might think more intelligently than we do. … [T]his new danger … is certainly something which can give us anxiety."

So far, the most general approach to creating generally intelligent machines is to provide them with our desired objectives and with algorithms for finding ways to achieve those objectives. Unfortunately, we may not specify our objectives in such a complete and well-calibrated fashion that a machine cannot find an undesirable way to achieve them. This is known as the "value alignment" problem, or the "King Midas" problem. Turing suggested "turning off the power at strategic moments" as a possible solution to discovering that a machine is misaligned with our true objectives, but a superintelligent machine is likely to have taken steps to prevent interruptions to its power supply.

How can we define problems in such a way that any solution the machine finds will be provably beneficial? One idea is to give a machine the objective of maximizing the true human objective, but without initially specifying that true objective: the machine has to gradually resolve its uncertainty by observing human actions, which reveal information about the true objective. This uncertainty should avoid the single-minded and potentially catastrophic pursuit of a partial or erroneous objective. It might even persuade a machine to leave open the possibility of allowing itself to be switched off.

There are complications: humans are irrational, inconsistent, weak-willed, computationally limited and heterogeneous, all of which conspire to make learning about human values from human behaviour a difficult (and perhaps not totally desirable) enterprise. However, these ideas provide a glimmer of hope that an engineering discipline can be developed around provably beneficial systems, allowing a safe way forward for AI. Near-term developments such as intelligent personal assistants and domestic robots will provide opportunities to develop incentives for AI systems to learn value alignment: assistants that book employees into US$20,000-a-night suites and robots that cook the cat for the family dinner are unlikely to prove popular.

Scholars, philosophers, futurists and tech enthusiasts vary in their predictions for the advent of artificial general intelligence (AGI), with timelines ranging from the 2030s to never. However, given the possibility of an AGI working out how to improve itself into a superintelligence, it may be prudent – or even morally obligatory – to consider potentially feasible scenarios, and how serious or even existential threats may be avoided.

The creation of AGI may depend on converging technologies and hybrid platforms. Much of human intelligence is developed by the use of a body and the occupation of physical space, and robotics provides such embodiment for experimental and exploratory AI applications. Proof-of-concept for muscle and brain–computer interfaces has already been established: Massachusetts Institute of Technology (MIT) scientists have shown that memories can be encoded in silicon,[21] and Japanese researchers have used electroencephalogram (EEG) patterns to predict the next syllable someone will say with up to 90% accuracy, which may lead to the ability to control machines simply by thinking.[22]

Superintelligence could potentially also be achieved by augmenting human intelligence through smart systems, biotech, and robotics rather than by being embodied in a computational or robotic form.[23] Potential barriers to integrating humans with intelligence-augmenting technology include people's cognitive load, physical acceptance and concepts of personal identity.[24] Should these challenges be overcome, keeping watch over the state of converging technologies will become an ever more important task as AI capabilities grow and fuse with other technologies and organisms.

Advances in computing technologies such as quantum computing, parallel systems, and neurosynaptic computing research may create new opportunities for AI applications or unleash new unforeseen behaviours in computing systems.[25] New computing technologies are already having an impact: for instance, IBM's TrueNorth chip – with a design inspired by the human brain and built for "exascale" computing – already has contracts from Lawrence Livermore National Laboratory in California to work on nuclear weapons security.[26] While adding great benefit to scenario modelling today, the possibility of a superintelligence could turn this into a risk.

Conclusion

Both existing ASI systems and the plausibility of AGI demand mature consideration. Major firms such as Microsoft, Google, IBM, Facebook and Amazon have formed the Partnership on Artificial Intelligence to Benefit People and Society to focus on ethical issues and helping the public better understand AI.[27] AI will become ever more integrated into daily life as businesses employ it in applications to provide interactive digital interfaces and services, increase efficiencies and lower costs.[28] Superintelligent systems remain, for now, only a theoretical threat, but artificial intelligence is here to stay and it makes sense to see whether it can help us to create a better future. To ensure that AI stays within the boundaries that we set for it, we must continue to grapple with building trust in systems that will transform our social, political and business environments, make decisions for us, and become an indispensable faculty for interpreting the world around us.

Chapter 3.2 was contributed by Nicholas Davies, World Economic Forum, and Thomas Philbeck, World Economic Forum.

Endnotes

[1] Russell, Dewey, and Tegmark 2015.
[2] CB Insights 2016.
[3] Mizroch 2015.
[4] Martin 2012.
[5] Clark 2016.
[6] Bostrom 2014.
[7] Scherer 2016.
[8] Frey and Osborne 2015.
[9] Sherpany 2016.
[10] Bostrom 2014; Armstrong 2014.
[11] Wallach 2015.
[12] Hunt 2016.
[13] Chiel 2016.
[14] Maderer 2016.
[15] Talbot 2009.
[16] Russell, Dewey, and Tegmark 2015, p. 111
[17] Bloomberg 2016.
[18] US regulatory policy is aimed at end products such as automated vehicles rather than the underlying technical system or its development.
[19] Scherer 2016, p. 359.
[20] U.S. Department of Transportation 2016.
[21] Cohen 2013.
[22] Kelly 2016.
[23] Bostrom 2014, Chapter 3.
[24] Conversation with Aldo Faisal, Senior Lecturer in Neurotechnology, Imperial College London, 29 September 2016.
[25] Yirka 2016.
[26] Lawrence Livermore National Laboratory 2016.
[27] Hern 2016.
[28] Kime 2016.

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3.3: Physical Infrastructure Networks and the Fourth Industrial Revolution

Since the appearance of railways and canals, industrial revolutions have been characterized by the transformation of physical infrastructure networks as much as by production methods. Now the Fourth Industrial Revolution (4IR) is shaking up the interdependent set of critical physical infrastructure networks on which we all depend, including transport (road, rail, waterways, airports); energy (electricity, heat, fuel supply: gas, liquid and solid); digital communications (fixed, mobile); water (supply, waste water treatment, flood protection); and solid waste (collection, treatment, disposal). This process brings huge opportunities for innovation, but also complex risks.

The Economic Characteristics of Infrastructure Networks

The value of a physical infrastructure network increases with its scope. In communications (transport, digital), the more people a network connects, the more useful it becomes. In resource networks (energy, water), connecting more people can help build resilience and leverage economies of scale. Costs are high relative to returns in the early stages of building a network, and also later when connecting geographically remote areas with low population density: extending coverage to such areas usually requires government intervention, although 4IR technologies may shake up that economic logic by drastically cutting the costs of connectivity.

Because physical infrastructure networks are often natural monopolies as a result of barriers to entry, the public sector typically either provides those barriers or regulates them on behalf of their users. Regulators have to tread the delicate line between setting affordable tariffs and ensuring that capital can be found to invest in maintaining and renewing networks. The pendulum has swung between private and public capital funding of infrastructure: for example, private financiers backed the creation of railway networks in Europe and North America in the 19th century, some losing their shirts. But much of today's ageing physical infrastructure in advanced economies was built with public funding during the 20th century. Britain led the way in utility privatization in the 1980s and 1990s, and it has generally improved asset management and reduced costs for customers. On the other hand, private finance has typically shied away from large and risky new assets, such as nuclear reactors. Uncertainties related to the 4IR play a part in that reluctance.

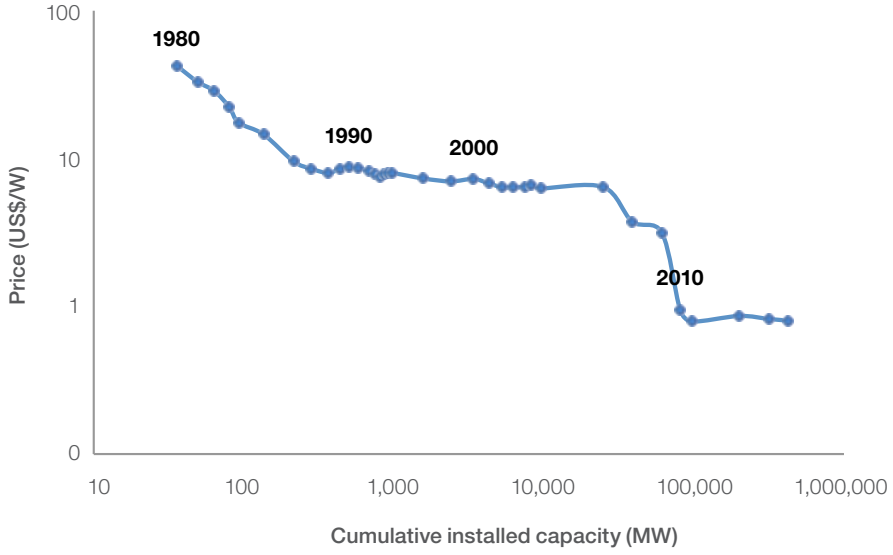
With tight public finances, governments and regulators are having to devise mechanisms for leveraging private finance while seeking to avoid the inflexibility and questions over value for money that have dogged public-private infrastructure finance in the past. It is still unclear how the enormous investment needs for some kinds of infrastructure are going to be met.

The Revolution

Electricity powered the Second and Third Industrial Revolutions, as networks achieved economies of scale by connecting large plants over high-voltage transmission grids to local distribution networks reaching many users. This aggregation of users helped to smooth out much of the local variation in demand, so steady-running base-load plants could be the workhorses of the network, with extra capacity patched in to deal with daily and seasonal peaks. Prohibitively high barriers to entry meant there was little competitive pressure to reduce the significant amount of energy lost as waste heat in the generation, transmission and distribution of electricity.

All of that is now changing. Collapsing prices of photo-voltaic cells make solar panels price-competitive with large-scale generation (Figure 3.3.1). The cost of offshore wind is also dropping fast, with firms such as DONG Energy and Vattenfall bidding prices down as low as €60 per Megawatt hour. Innovation in storage technology is helping with intermittency challenges – from large-scale storage to household battery

Figure 3.3.1: The Falling Price of Photo-Voltaic Modules



Source: Bloomberg New Energy Finance.

Note: Prices are in constant 2015 US$.

units and plugged-in electric vehicles, which will provide an additional buffer. The 4IR is moving electricity networks away from needing to be large-scale, top-down systems.

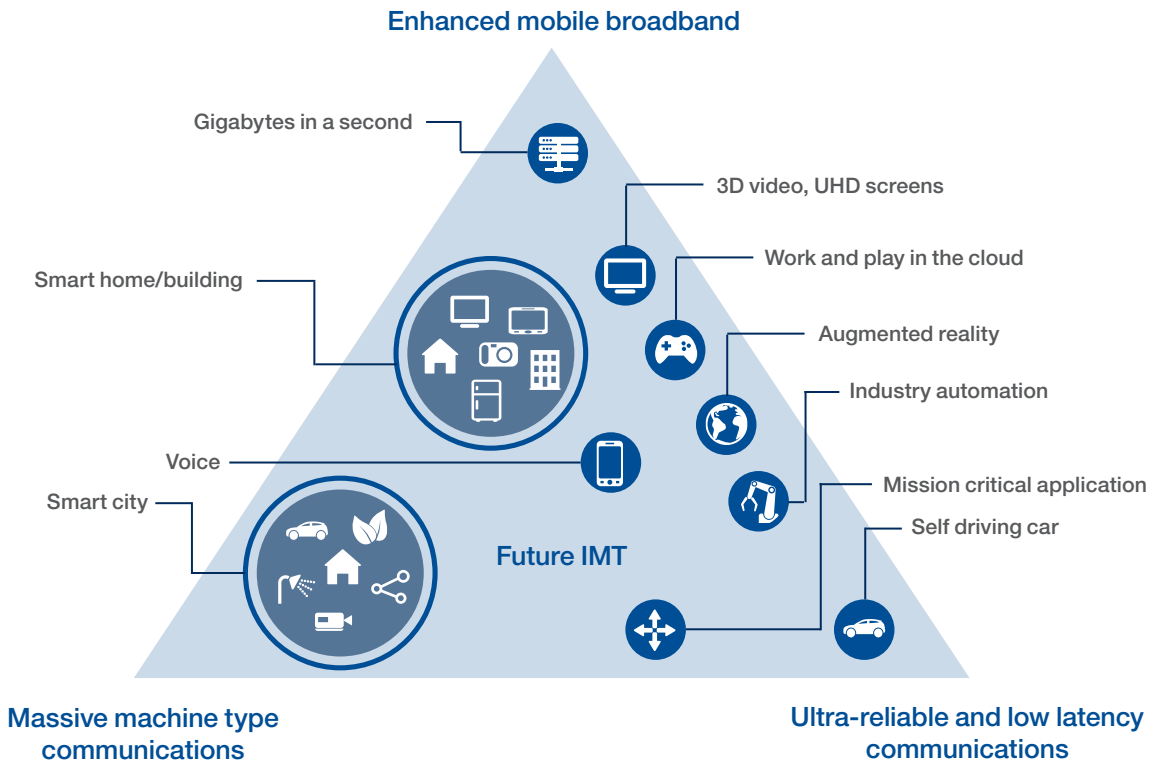
Technological innovations will increasingly offer households and firms the possibility of going "off-grid" entirely – but even if they increasingly generate their own power, most are still likely to want to remain connected to the high-voltage networks that are the backbone of today's electricity supply systems. Indeed, the rising use of solar, wind and tide power – with their associated intermittency issues and their greater need to tap the energy storage possibilities of hydropower in mountainous regions – will increase the appeal of high-voltage connections over long distances. But the growing scope for businesses and homes to supply and store their own electricity will make electricity networks multi-scale and less "lumpy" in terms of their capital requirements.

Beyond supply and storage, technology is improving efficiency by integrating supply and demand. Until very recently, energy suppliers and network operators have had to rely on crude methods to forecast demand for electricity. Big data, pervasive sensors and the Internet of Things are making it easier for users to monitor and control their energy demand, and for grids to predict and manage energy supply. In a world of prosumers and distributed suppliers, the challenges are how to synchronize supply and demand and pay for resilience.

Water could also transition from centralized networks towards more distributed systems. New materials and sensor technologies allow treatment at the household or community level, creating opportunities to harvest rainwater and directly reuse waste water. For the time being, economies of scale still favour large, centralized plants in existing urban areas: they also allow utilities to monitor water quality centrally and address failures quickly. Relying on localized water storage would also create challenges in prolonged periods of drought. But centralized networks are costly to create, and the balance of costs and benefits is beginning to tip in favour of distributed water systems if cities can be planned for these systems from the outset.

Regarding communications, the 4IR will continue to shift the balance between mobile and fixed networks. To improve mobile broadband, 5G technologies are envisaged to provide much faster data transfer (>1 Gigabyte per second) and reduced end-to-end latency (sub-1ms). By consolidating existing layers of technology, such as 2G, 3G, 4G and Wi-Fi, 5G will also improve coverage and 'always-on' reliability – it is an ensemble of different technologies, rather than a single type of new technology. Although the experience of those previous technologies suggests that new uses

Figure 3.3.2: Usage Scenarios for Mobile Technologies



Source: ITU 2015.

for 5G will emerge after deployment, two key roles are already anticipated for 5G: providing gigabit connectivity for businesses and consumers for a range of content, applications and services (the top of the pyramid); and enabling ultra-reliable, low latency machine-to-machine (M2M) communication (the bottom of the pyramid), which will help to achieve objectives in other infrastructure systems, such as easing congestion (Figure 3.3.2).

Governments are facing a difficult decision about whether to be first movers in rolling out 5G or wait to learn lessons from first movers, in the expectation that costs will decrease. For now, the bandwidth of fibre-optic cables remains hard to beat – but it is also expensive in towns and cities: 80% of the costs are attached not to the technology itself but to the labour-intensive process of digging trenches and laying ducts. Uncertainty about future technological development can inhibit investment: is it better to dig trenches for cables or wait for 5G? The same dilemma applies to other types of infrastructure – for example, in the time it takes to roll out smart metres, new and better metres are being developed.

While improving some infrastructure assets, the 4IR promises to ease pressure on others by finding alternative ways to deliver the same functionality. For example, meeting in virtual reality is becoming an increasingly acceptable substitute for physical business travel, while drones may substitute for delivery vans in cities. Satellite technologies will help to fill the gaps in digital connectivity where fixed or terrestrial mobile technologies are not cost-effective. Where energy companies once defined themselves by their physical infrastructure assets, they increasingly see themselves as being in the business of providing specific services such as heating and lighting. As the 4IR creates new ways to deliver services, it may begin to challenge whether infrastructure should be seen as a special category at all.

The Risks

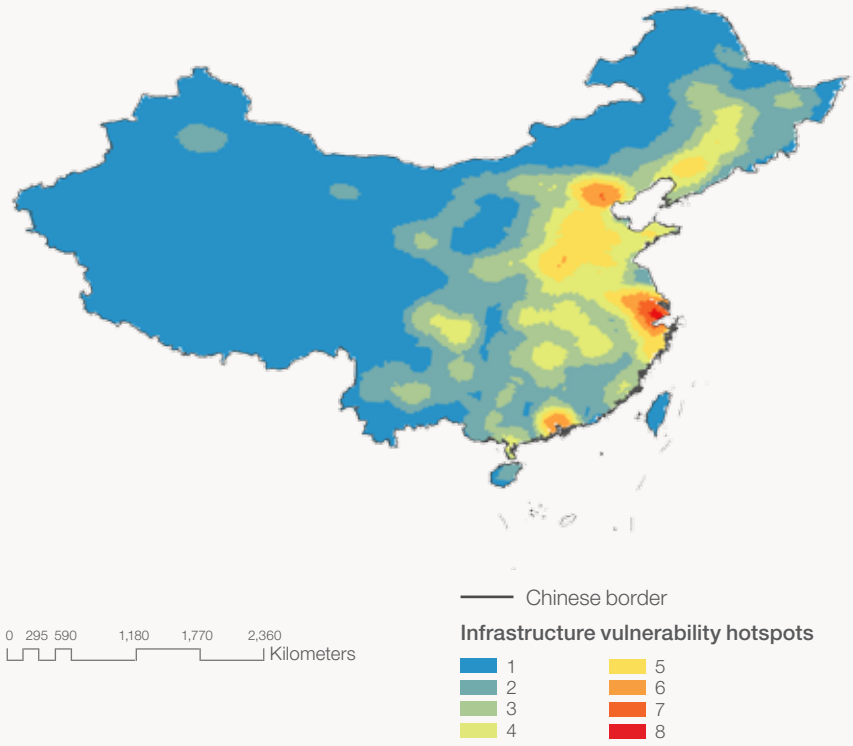
In theory, greater connectivity brings intrinsic resilience: electricity networks with more supply points, for example, should be less prone to failure. However, as different infrastructure networks become more interdependent, there is also growing scope for systemic failures to cascade across networks and affect society in multiple ways. In particular, electricity networks are now assuming an increasingly central role in many areas of life, such as road transportation and heating (taking over from gas and liquid fuels).

Systemic risks can come from many directions – whether these are cyberattacks or software glitches, solar storms or even just unexpectedly

Box 3.3.1: Mapping Infrastructure Vulnerability to Natural Hazards

An "infrastructure criticality hotspot" is defined as a geographical location where there is a concentration of critical infrastructure, measured according to the number of customers directly or indirectly dependent upon it. In the map of China below, red spots indicate where the highest numbers of people and businesses would be affected if a natural disaster caused infrastructure failure. According to this research, from the Environmental Change Institute at the University of Oxford, China's top infrastructure hotspots are Beijing, Tianjin, Jiangsu, Shanghai and Zhejiang.

Given the scale of China's manufacturing production and its role in the global supply chain, the business impacts of natural disasters could be astronomical: flooding in the more economically developed coastal provinces already accounts for more than 60% of the country's losses due to flooding.[1] The Oxford study finds that severe flooding events could disrupt infrastructure (rail, aviation, shipping and water) services for an average of 103 million people, while drought could affect an average of 6 million electricity users.



Source: Hu et al. 2016
Note: http://www.mwr.gov.cn/zwzc/hygb/zgshzhgb/201311/t20131104_515863.html

widespread and persistent clouds – and the increased complexity bring brought about by the 4IR makes the severity of those risks very difficult to estimate (Box 3.3.1). Society is increasingly dependent on information and communication technology networks in particular, and these have their own dependencies and vulnerabilities. In a 20th-century electricity network, it is possible to analyse the consequences of any given sub-station failing. That becomes impossible when every household is supplying and storing electricity and constantly adapting how much it uses based on price signals: we may suspect that our networks are acceptably resilient, but we cannot model them accurately enough to be sure.

Because the 4IR intensifies networks' reliance on each other, there is a need for information sharing – utility providers tend to understand their own systems well, while often being more or less in the dark about the resilience of the systems to which they are connected. However, concerns about commercial confidentiality and security increase the challenge of developing protocols for information sharing that would help dependent customers to understand their risks. Not only infrastructure providers but also businesses need to understand risks and resilience more fully: analysis of supply chain risk tends to focus more on physical sites than the infrastructure networks that sustain those sites and move goods and services between them.

Governance of Infrastructure Networks in the 4IR

Like infrastructure networks themselves, arrangements for their governance have evolved incrementally and mostly siloed by sector – not least because ownership arrangements can be so different, ranging from highly competitive privatized markets (e.g. in mobile phone provision) through regulated monopolies, public-private partnerships, state-owned enterprises and direct public provision.[1] Governments are increasingly recognizing that this fragmented approach is becoming unfit for purpose in the 4IR. As networks become interconnected – for example, as digital technologies enable the routing of vehicles and the management of electricity and water demand – a "system-of-systems" approach to governance is needed. That requires appropriate sharing of information among network operators, and also requires regulators adopting common principles across networks.
Just as network operators and businesses need to better understand and manage systemic risks, governments and regulators need to take a wider view. Examples of new governance structures that recognize the need for a more integrated approach include the National Infrastructure Commission in the United Kingdom, Infrastructure Australia, and the National Infrastructure Unit in New Zealand. These new entities are having to navigate tensions between taking a national-level strategic approach to articulating needs for infrastructure to support growth and productivity and creating space for competition and innovation.

While the 4IR is creating complex new challenges for planners and regulators, it is also providing powerful new tools for monitoring and analysing system performance at hitherto unprecedented spatial and temporal scales – and testing resilience through simulation. Modelling exercises in a virtual environment will never give infallible results, but in itself the exercise of constructing and testing models can help to expose vulnerabilities in system resilience. Alongside their traditional role of minimizing the harmful effects of natural monopolies, infrastructure regulators in the 4IR should be paying more attention to systemic risks, building technical capabilities and standards for information sharing and stress testing.

Chapter 3.3 was contributed by Jim Hall, Oxford Martin School, University of Oxford.

Endnotes

[1] OECD 2015.

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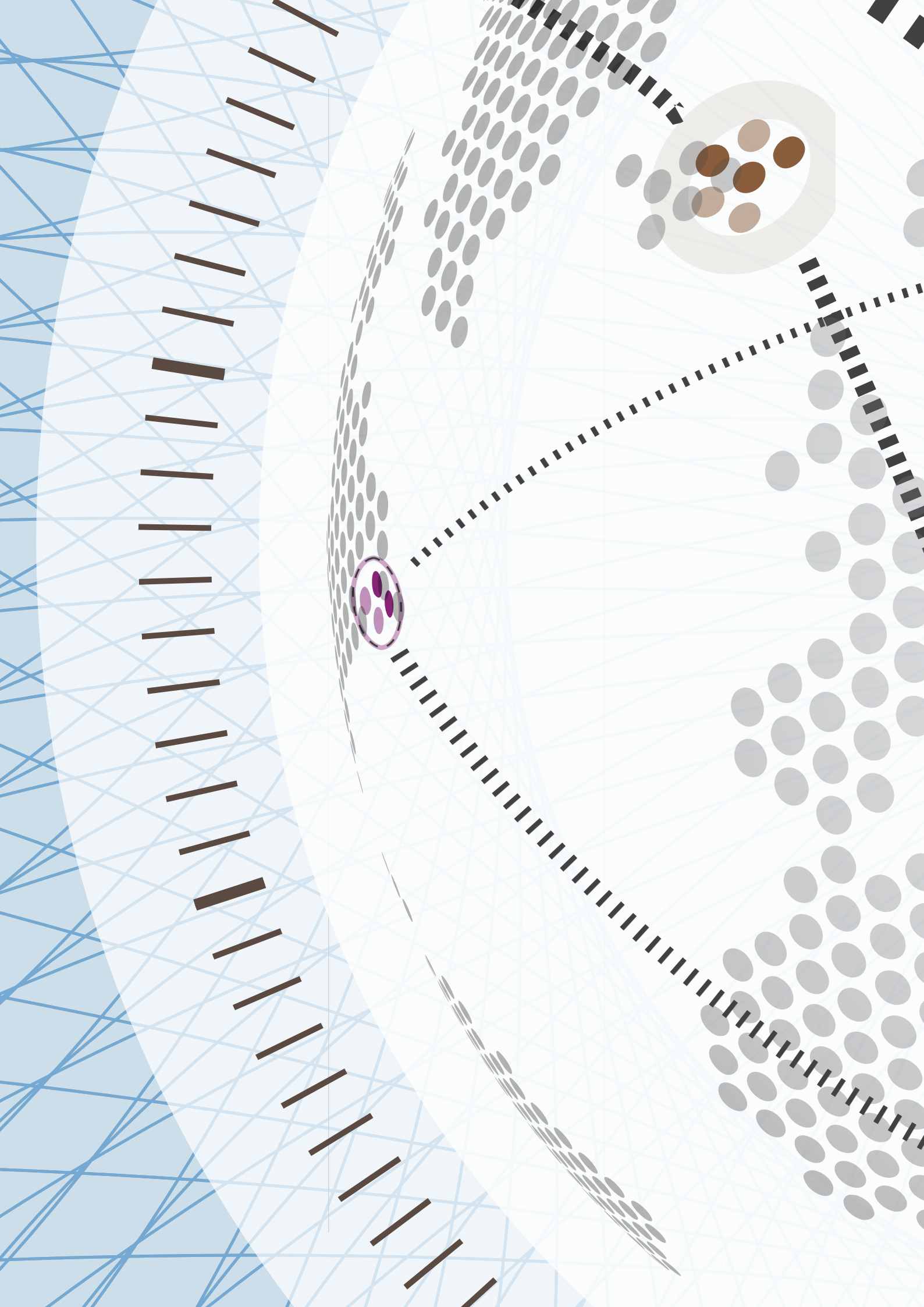
Conclusion

The 12th edition of *The Global Risks Report* is published at a time when deep-rooted social and economic trends are manifesting themselves increasingly disruptively across the world. Persistent inequality, particularly in the context of comparative global economic weakness, risks undermining the legitimacy of market capitalism. At the same time, deepening social and cultural polarization risks impairing national decision-making processes and obstructing vital global collaboration.

Technology continues to offer us the hope of solutions to many of the problems we face. But the pace of technological change is also having unsettling effects: these range from disrupting labour markets through automation to exacerbating political divisions by encouraging the creation of rigid communities of like-minded citizens. We need to become better at managing technological change, and we need to do it quickly.

Above all, we must redouble our efforts to protect and strengthen our systems of global collaboration. Nowhere is this more urgent than in relation to the environment, where important strides have been made in the past year but where much more remains to be done. This is a febrile time for the world. We face important risks, but also opportunities to take stock and to work together to find new solutions to our shared problems. More than ever, this is a time for all stakeholders to recognize the role they can play by exercising responsible and responsive leadership on global risks.



Appendices

Appendix A: Descriptions of Global Risks, Trends and Emerging Technologies 2017

Global Risks
A "global risk" is defined as an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next 10 years.

	Global Risk	Description
Economic Risks	Asset bubbles in a major economy	Unsustainably overpriced assets such as commodities, housing, shares, etc. in a major economy or region
	Deflation in a major economy	Prolonged near-zero inflation or deflation in a major economy or region
	Failure of a major financial mechanism or institution	Collapse of a financial institution and/or malfunctioning of a financial system that impacts the global economy
	Failure/shortfall of critical infrastructure	Failure to adequately invest in, upgrade and/or secure infrastructure networks (e.g. energy, transportation and communications), leading to pressure or a breakdown with system-wide implications
	Fiscal crises in key economies	Excessive debt burdens that generate sovereign debt crises and/or liquidity crises
	High structural unemployment or underemployment	A sustained high level of unemployment or underutilization of the productive capacity of the employed population
	Illicit trade (e.g. illicit financial flows, tax evasion, human trafficking, organized crime, etc.)	Large-scale activities outside the legal framework such as illicit financial flows, tax evasion, human trafficking, counterfeiting and/or organized crime that undermine social interactions, regional or international collaboration, and global growth
	Severe energy price shock (increase or decrease)	Significant energy price increases or decreases that place further economic pressures on highly energy-dependent industries and consumers
	Unmanageable inflation	Unmanageable increases in the general price levels of goods and services in key economies
Environmental Risks	Extreme weather events (e.g. floods, storms, etc.)	Major property, infrastructure and/or environmental damage as well as loss of human life caused by extreme weather events
	Failure of climate-change mitigation and adaptation	The failure of governments and businesses to enforce or enact effective measures to mitigate climate change, protect populations and help businesses impacted by climate change to adapt
	Major biodiversity loss and ecosystem collapse (terrestrial or marine)	Irreversible consequences for the environment, resulting in severely depleted resources for humankind as well as industries
	Major natural disasters (e.g. earthquake, tsunami, volcanic eruption, geomagnetic storms)	Major property, infrastructure and/or environmental damage as well as loss of human life caused by geophysical disasters such as earthquakes, volcanic activity, landslides, tsunamis, or geomagnetic storms
	Man-made environmental damage and disasters (e.g. oil spills, radioactive contamination, etc.)	Failure to prevent major man-made damage and disasters, including environmental crime, causing harm to human lives and health, infrastructure, property, economic activity and the environment

	Global Risk	Description
Geopolitical Risks	Failure of national governance (e.g. failure of rule of law, corruption, political deadlock, etc.)	Inability to govern a nation of geopolitical importance as a result of weak rule of law, corruption or political deadlock.
	Failure of regional or global governance	Inability of regional or global institutions to resolve issues of economic, geopolitical or environmental importance
	Interstate conflict with regional consequences	A bilateral or multilateral dispute between states that escalates into economic (e.g. trade/currency wars, resource nationalization), military, cyber, societal or other conflict.
	Large-scale terrorist attacks	Individuals or non-state groups with political or religious goals that successfully inflict large-scale human or material damage.
	State collapse or crisis (e.g. civil conflict, military coup, failed states, etc.)	State collapse of geopolitical importance due to internal violence, regional or global instability, military coup, civil conflict, failed states, etc.
	Weapons of mass destruction	The deployment of nuclear, chemical, biological and radiological technologies and materials, creating international crises and potential for significant destruction
Societal Risks	Failure of urban planning	Poorly planned cities, urban sprawl and associated infrastructure that create social, environmental and health challenges
	Food crises	Inadequate, unaffordable, or unreliable access to appropriate quantities and quality of food and nutrition on a major scale
	Large-scale involuntary migration	Large-scale involuntary migration induced by conflict, disasters, environmental or economic reasons
	Profound social instability	Major social movements or protests (e.g. street riots, social unrest, etc.) that disrupt political or social stability, negatively impacting populations and economic activity
	Rapid and massive spread of infectious diseases	Bacteria, viruses, parasites or fungi that cause uncontrolled spread of infectious diseases (for instance as a result of resistance to antibiotics, antivirals and other treatments) leading to widespread fatalities and economic disruption
	Water crises	A significant decline in the available quality and quantity of fresh water, resulting in harmful effects on human health and/or economic activity
Technological Risks	Adverse consequences of technological advances	Intended or unintended adverse consequences of technological advances such as artificial intelligence, geo-engineering and synthetic biology causing human, environmental and economic damage
	Breakdown of critical information infrastructure and networks	Cyber dependency that increases vulnerability to outage of critical information infrastructure (e.g. internet, satellites, etc.) and networks, causing widespread disruption
	Large-scale cyberattacks	Large-scale cyberattacks or malware causing large economic damages, geopolitical tensions or widespread loss of trust in the internet
	Massive incident of data fraud/theft	Wrongful exploitation of private or official data that takes place on an unprecedented scale

Trends

A "trend" is defined as a long-term pattern that is currently evolving and that could contribute to amplifying global risks and/or altering the relationship between them.

Trend	Description
Ageing population	Ageing populations in developed and developing countries driven by declining fertility and decrease of middle- and old-age mortality
Changing landscape of international governance	Changing landscape of global or regional institutions (e.g. UN, IMF, NATO, etc.), agreements or networks
Changing climate	Change of climate, which is attributed directly or indirectly to human activity, that alters the composition of the global atmosphere, in addition to natural climate variability
Degrading environment	Deterioration in the quality of air, soil and water from ambient concentrations of pollutants and other activities and processes
Growing middle class in emerging economies	Growing share of population reaching middle-class income levels in emerging economies
Increasing national sentiment	Increasing national sentiment among populations and political leaders affecting countries' national and international political and economic positions
Increasing polarization of societies	Inability to reach agreement on key issues within countries because of diverging or extreme values, political or religious views
Rising chronic diseases	Increasing rates of non-communicable diseases, also known as "chronic diseases", leading to rising costs of long-term treatment and threatening recent societal gains in life expectancy and quality
Rising cyber dependency	Rise of cyber dependency due to increasing digital interconnection of people, things and organizations
Rising geographic mobility	Increasing mobility of people and things due to quicker and better-performing means of transport and lowered regulatory barriers
Rising income and wealth disparity	Increasing socioeconomic gap between rich and poor in major countries or regions
Shifting power	Shifting power from state to non-state actors and individuals, from global to regional levels, and from developed to emerging market and developing economies
Rising urbanization	Rising number of people living in urban areas resulting in physical growth of cities

Emerging Technologies

Emerging Technology	Description
3D printing	Innovations in printing using various types of materials to move beyond prototyping and towards increasingly distributed manufacturing and medical applications that range from a greater use of technologies such as contour crafting in construction to the opportunity to develop printed biological materials, such as organ tissues, bone and muscle
Advanced materials and nanomaterials	Innovation in chemistry and physics resulting in the creation of new material substances, smart materials, 2D materials and other breakthroughs in properties and fabrication ranging from thermoelectric properties and shape retention to magnetic and mechanical functionalities

Emerging Technologies

Emerging Technology	Description
Artificial intelligence and robotics	Advances in automated processes ranging from manufacturing to driverless vehicles and automated knowledge work, enabled by highly competent cyber-physical systems and machines that can substitute for human beings to complete various tasks most often associated with thinking, multitasking, and fine motor skills
Biotechnologies	Innovations in genome editing, gene therapies, and other forms of genetic manipulation and synthetic biology resulting in additions to the registry of sequenced species of animals as well as human DNA, the creation of previously non-existent organisms, and modifications to microbes and organisms for medical, agricultural and industrial applications, including integrating them with electronic and computing advancements
Energy capture, storage and transmission	Breakthroughs in energy technologies, including advanced batteries and fuel cells, orbiting solar arrays, tidal energy capture, wind and bioenergy, as well as advances in nuclear fusion containment, smart grid systems, wireless energy transfer, and increased fuel cell fabrication efficiencies
Blockchain and distributed ledger	Developments in cryptographic systems that manage and verify distributed transaction data on a public ledger, increasing transparency and securing an immutable record for application to cryptocurrencies such as bitcoin as well as for verification of varieties of transactions across industries, especially in financial technologies (FinTech)
Geoengineering	Creation and development of technological processes that intercede in the Earth's geological and climatic systems, ranging from land reclamation to atmospheric seeding in order to influence weather patterns or remove carbon dioxide
Proliferation and ubiquitous presence of linked sensors	Proliferation and ubiquitous presence of linked sensors, also known as the "Internet of Things", combined with sophisticated large-scale data analytics that will connect, track and manage physical products, logistics systems, energy grids and more by sending and receiving data over widespread digital infrastructures
Neurotechnologies	Creation of new methods for insight into, and control of, the functionality and processing dimensions of the human brain, allowing for the ability to read, influence and communicate brain activity through various secondary technological dimensions such as smart drugs, neuroimaging, bioelectronic interfaces, machine-brain interfaces and brainwave decoding and manipulation
New computing technologies	Innovations in materials and assemblages used to process or store digital information, such as centralized cloud computing, quantum computing, neural network processing, biological data storage, and optical computing, including new software development, cryptography, and the cybersecurity processes associated with each
Space technologies	Technologies that can be used in space that will increase the ability of both public and private entities to access, explore, and create new forms of value such as microsatellites, reusable rockets, integrated rocket-jet engines, optical and imaging technologies, sensor developments, resource exploitation, laser and communications technologies, space exploration and habitat developments, and techno-scientific breakthroughs that are transferable to the marketplace
Virtual and augmented realities	Development of sophisticated immersive virtual environments that can range from heads-up displays and holographic readouts to fully mixed digital and physical environments and complete virtual worlds and interfaces

Appendix B: Global Risks Perception Survey and Methodology 2016

Definitions and Changes

The Global Risks Report 2017 is based on an improved methodology; however the results are therefore largely comparable. The *Report* adopts the following definitions of global risk and trend:

Global risk: an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next 10 years.

Trend: a "trend" is defined as a long-term pattern that is currently evolving and that could contribute to amplifying global risks and/or altering the relationship between them.

The list of risks and trends assessed in the Global Risks Perception Surveys (GRPS) remains unchanged with the exception of the addition of the global risk "Failure of regional or global governance" (defined as the *inability of regional or global institutions to resolve issues of economic, geopolitical or environmental importance*). As a result, the *Report* covers 30 global risks this year.

Some of the names of the trends were modified to better reflect long-term pattern characteristic of trends (for instance, the trend "rise of chronic diseases" was edited to "rising chronic diseases"). The definitions were mainly unchanged.

This year's GRPS included an entire section on emerging technologies. After consultations with experts, 12 critical emerging technologies were identified; selected findings are described in Part 3 of the *Report*.

The following section describes the survey and methodology in greater detail.

The Global Risks Perceptions Survey

The Global Risks Perception Survey (GRPS), discussed in Part 1, is the main instrument used to assess global risks in this *Report*. The survey was conducted between early September and mid-October 2016 (from 07 September to 15 October 2016) among the World Economic Forum's multistakeholder communities of leaders from business, government, academia and non-governmental and international organizations as well as members of the Institute of Risk Management.

This year, the GRPS is a key instrument used as supporting data for the elaboration of the *Report*. For this year's *Report*, the GRPS went through an important review to ensure the quality of the results. This process was performed in collaboration with the Global Risks Perception Survey Review Group on *The Global Risks Report 2017*, a group composed of experts in survey methodology and risks perception (see Acknowledgements section).

Among the most significant improvements are the changes to the scales of the Global Risks Landscape. Indeed, the impact scale has changed this year from an abstract 1–7 scale, subject to interpretation and thus bias, to a more substantive and meaningful scale of impact measurement (i.e. minimal, minor, moderate, severe, catastrophic). On the likelihood scale, the scale of 1–7 was kept but a particular probability was attached to each number in order to ensure that all respondents had the same understanding of the likelihood being considered. Throughout the survey, the questions were modified and the phrasing was refined to reduce any ambiguity.

Raw responses were cleaned in order to improve overall data quality and completeness. Surveys with a completion rate below 50% were dropped, reducing the number of available responses from 989 to 745. The respondents did not provide sufficient information about their gender or the sector in which they work in 92 and 119 cases, respectively. Similarly, 93 respondents did not indicate the country in which they are based.

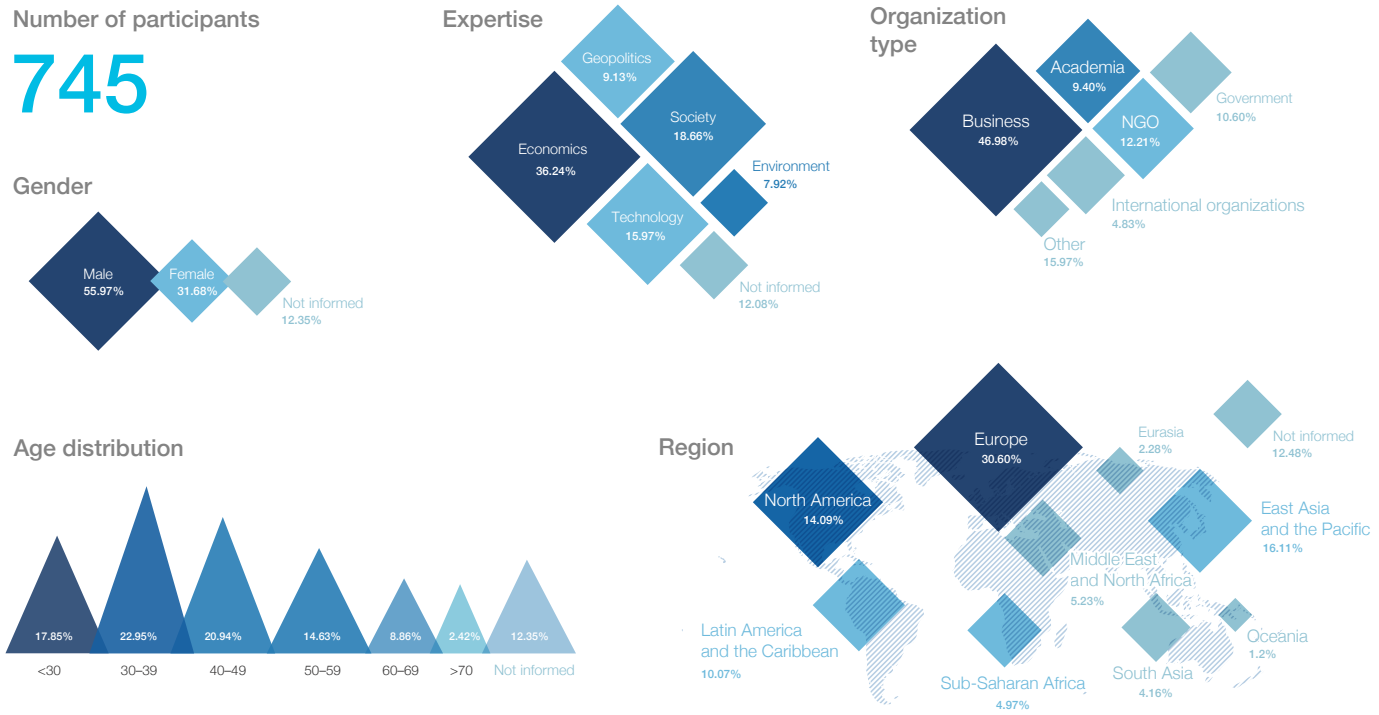
Figure B.1 presents the profile of the 745 survey respondents remaining in the sample. To capture the voice of youth, the survey also targeted the World Economic Forum's community of Global Shapers.[1] Respondents under 30 accounted for about one-fifth of total respondents.

Analysis

The Global Risks Landscape 2017 (Figure 3)

Respondents were asked to assess the likelihood and global impact of each of the 30 risks. For each risk, they were asked, "What is the likelihood of [the risk] occurring globally within the next 10 years?" and "What is the negative impact for several countries or industries within the next 10 years?" For the first question, the possible answers ranged from 1 ("extremely unlikely" with an associated probability of occurrence lower than 5%) to 7 ("extremely likely" with an associated probability of occurrence greater than 95%). For the question on impact, respondents could select one of five choices: "minimal", "minor", "moderate", "severe", or "catastrophic". These five alternatives were turned into a 1–5 scale (1 = minimal, 5 = catastrophic). It is worth noting that, as a consequence of the scale modification, the impact results cannot be compared with those of previous years.

Figure B.1: Survey Sample Composition



Source: World Economic Forum Global Risks Perception Survey 2016.

Note: Reported shares are based on number of valid responses: Gender: 653 responses; Expertise: 655; Organization type: 626; Age distribution: 653; Region: 652.

Respondents could also choose "No Opinion" if they felt unable to provide an informed answer. Respondents could also leave the question completely blank. For each risk, partial responses – those assessing only the likelihood of occurrence or only its impact – were dropped. A simple average for both likelihood and impact for each of the 30 global risks was calculated on this basis.

Formally, for any given risk *i*, its likelihood and impact, denoted respectively $likelihood_i$ and $impact_i$, are:

$$likelihood_i = \frac{1}{N_i}\sum_{n=1}^{N_i^1} likelihood_{i,n}$$

$$impact_i = \frac{1}{N_i}\sum_{n=1}^{N_i^2} impact_{i,n}$$

where N_i is the number of respondents for risk *i*, and $likelihood_{i,n}$ and $impact_{i,n}$ are, respectively, the likelihood and impact assigned by respondent *n* to risk *i*. The likelihood is measured on a scale of 1–7 and the impact on a scale of 1–5. N_i is the number of respondents for risk *i* who assessed both the likelihood and impact of that specific risk (the answers of respondents who left one of the two questions blank were not taken into account).

The Global Risks Interconnections Map 2017 (Figure 4) and the Risks-Trends Interconnections Map 2017 (Figure 1)

To draw the Global Risks Interconnections Map (Figure 4, inside rear cover), survey respondents were asked to answer the following question: "Global risks are not isolated and it is important to assess their interconnections. In your view, which are the most strongly connected global risks? Please select three to six pairs of global risks."

Similarly, for the Risks-Trends Interconnections Map 2017 (Figure 1, inside front cover), respondents had to identify up to three trends that they consider important in shaping the global agenda in the next 10 years and the three risks that are driven by each of those trends. For completeness, the two questions read "Which are the three most important trends that will shape global development in the next 10 years?" and "For each of the three trends identified in the previous question, select up to three global risks that are most strongly driven by these trends." The information thereby obtained was used to construct the Risks-Trend Interconnections Map 2017.

In both cases, a tally was made of the number of times each pair was cited. This value was then divided by the count of the most frequently cited pair. As a final step, the square root of this ratio was taken to dampen the long-tail effect (i.e. a few very strong links, and many weak ones) and to make the differences more apparent across the weakest connections. Out of the 406 possible pairs of risks, 167 or 41% were not cited. Similarly, out of the possible 377 trend-risk combinations, 33 or 9% were not cited. Formally, the intensity of the interconnection between risks *i* and *j* (or between trend *i* and risk *j*), denoted $interconnection_{ij}$, corresponds to:

$$interconnection_{ij} = \sqrt{\frac{\sum_{n=1}^{N} pair_{ij,n}}{pair_{max}}}$$

with

$$pair_{max} = \max_{ij}\left(\sum_{n=1}^{N} pair_{ij,n}\right)$$

where N is the number of respondents.

Variable $pair_{ij,n}$ is 1 when respondent n selected the pair of risks i and j as part of his/her selection. Otherwise, it is 0. The value of the interconnection determines the thickness of each connecting line in the graph, with the most frequently cited pair having the thickest line.

In the Global Risks Landscape and Risks-Trends Interconnections Maps, the size of each risk is scaled according to the degree of weight of that node in the system. Moreover, in the Risks-Trends Interconnections Map, the size of the trend represents the perception of its importance in shaping global development (answer to the first part of the question on trend, as explained above); the biggest trend is the one considered to be the most important in shaping global development.

The placement of the nodes in the Global Risks-Trends Interconnections Map was computed using ForceAtlas2, a force-directed network layout algorithm implemented in Gephi software, which minimizes edge lengths and edge crossings by running a physical particle simulation.[2]

The Emerging Technologies Matrix (Figure 3.1.1)

For the first time this year, the GRPS included questions on emerging technologies. The first question asked in this section was on the consequences of emerging technologies. For each of the 12 emerging technologies identifies, respondents had to answer the following questions: "How likely is this emerging technology to bring **significant benefits** within the next 10 years?" and "How likely is this emerging technology to bring **severe negative consequences** within the next 10 years?" and finally "How confident are you about your responses for this emerging technology?" For the first two questions, respondents could answer from 1 (extremely unlikely) to 7 (extremely likely). Similar to the likelihood questions used to build the Global Risks Landscape 2017, probabilities were attached to each selected risk. For the question on the level of confidence, respondents could select an answer ranging from 1 (extremely low confidence) to 7 (extremely confident).

Here again, respondents were given the option of choosing "No Opinion" if they felt unable to provide an informed answer. Respondents could also leave the question completely blank. A simple average of responses to the benefits, negative consequences, and level of confidence questions was calculated. Formally, for any given emerging technology i, its benefits and negative consequences, denoted respectively $benefits_i$ and $neg.consequences_i$, are:

$$benefits_i = \frac{1}{N_i}\sum_{n=1}^{N_i} benefits_{i,n}$$

$$neg.consequences_i = \frac{1}{N_i}\sum_{n=1}^{N_i} neg.consequences_{i,n}$$

where N_i is the number of respondents for emerging technology i, and $benefits_{i,n}$ and $neg.consequences_{i,n}$ are, respectively, the benefits and negative consequences assigned by respondent n to the emerging technology i and measured on a scale from 1 to 7. N_i is the number of respondents for the emerging technology i who assessed both the benefits and the negative consequences of that emerging technology (the answers of respondents who left one of the two questions blank were not taken into account).

Other Emerging Technologies Questions (Figure 3.1.3)

After the questions on the consequences of emerging technology, the respondents had to select the three emerging technologies that need better governance. The exact question is: "Please select the three emerging technologies where you believe better governance is most needed. By 'governance' we mean the rules, norms, standards and/or institutions that allow stakeholders to take effective decisions that maximize the benefits and minimize the negative consequences of a technology." The computation for each emerging technology i is:

$$governance_i = \frac{1}{N}\sum_{n=1}^{N} governance_{i,n}$$

where N is the number of respondents to the survey, and variable $governance_{i,n}$ is 1 when respondent n selected the pair of risks i and j as part of his/her selection. Otherwise, it is 0. As a result, $governance_i$ (the score) measures the percentage of respondents selecting the emerging technology i.

The respondents had to then answer a question about which emerging technologies exacerbate each of the five categories of global risks. The question reads: "For each question, please select the three emerging technologies that you believe will most significantly exacerbate global risks within the stated risk category. By 'exacerbate' we mean increase the likelihood and/or impact of those risks." For each risk category, the results are computed as:

$$exacerbate_{i,\,a} = \frac{1}{N}\sum_{n=1}^{N} exacerbate_{i,a,n}$$

where N is the number of respondents to the survey and, for emerging technology i for the risk category a (economic risks, environmental risks, geopolitical risks, societal risks, or technological risks), variable $exacerbate_{i,a,n}$ is 1 when respondent n selected the pair of risks i and j as part of his/her selection. Otherwise, it is 0. As a result, $exacerbate_{i,a}$ is the score assigned to emerging technology i for risk category a and measured as a percentage of respondents selecting this emerging technology.

Reference

Jacomy, M., T. Venturini, S. Heymann, and M. Bastian. 2014. "ForceAtlas2: A Continuous Graph Layout Algorithm for Handy Network Visualization Designed for the Gephi Software." *PLoS ONE* 9(6): e98679. doi:10.1371/journal.pone.0098679

Endnotes

[1] The Global Shapers Community is a network of hubs developed and led by young people who are exceptional in their potential, achievement and drive to make a contribution to their communities; see http://www.weforum.org/community/global-shapers

[2] See Jacomy et al. 2014.

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Box 1.2: Climate Change and the 4IR by Al Gore, Generation Investment Management

Box 2.1.1: Social Media and the Distortion of Information by Walter Quattrociocchi, Northeastern University

Box 3.2.1: Artificial Intelligence and the Future of Warfare by Jean-Marc Rickli, Geneva Centre for Security Policy

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