

Cambridge Centre for Risk Studies
Cambridge Risk Framework

Geopolitical Conflict: Stress Test Scenario

CHINA-JAPAN GEOPOLITICAL CONFLICT SCENARIO



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**The Global Economy
The Systemic Impact of a War**

Imports and exports between the world's national economies. Colour coding shows the economic impact of the Sino-Japanese geopolitical conflict scenario on each country.

Cambridge Centre for Risk Studies
University of Cambridge Judge Business School
Trumpington Street
Cambridge, CB2 1AG
United Kingdom
enquiries.risk@jbs.cam.ac.uk
<http://www.risk.jbs.cam.ac.uk/>

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This report describes a hypothetical scenario developed as a stress test for risk management purposes. It does not constitute a prediction. The Cambridge Centre for Risk Studies develops hypothetical scenarios for use in improving business resilience to shocks. These are contingency scenarios used for 'what-if' studies and do not constitute forecasts of what is likely to happen.

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Research Project Team

Geopolitical Conflict Project Lead

Dr Gary Bowman, *Research Associate*

Geopolitical Conflict Subject Matter Editors

Richard Hartley, *Co-Founder, Cytora Ltd.*

Joshua Wallace, *Co-Founder, Cytora Ltd.*

Dr Ivan Ureta, *College of Economics and Political Science, Sultan Qaboos University, Oman*

Cambridge Centre for Risk Studies Research Team

Professor Daniel Ralph, *Academic Director*

Dr Michelle Tuveson, *Executive Director*

Dr Andrew Coburn, *Director of External Advisory Board*

Simon Ruffle, *Director of Technology Research*

Dr Gary Bowman, *Research Associate*

Dr Fabio Caccioli, *Research Associate*

Dr Scott Kelly, *Research Associate*

Dr Roxane Foulser-Piggott, *Research Associate*

Dr Louise Pryor, *Risk Researcher*

Andrew Skelton, *Risk Researcher*,

Ben Leslie, *Risk Researcher*

Dr Duncan Needham, *Risk Associate*

Consultants and Collaborators

Oxford Economics Ltd., with particular thanks to Fabio Ortalani, Senior Economist

Financial Networks Analytics Ltd., with particular thanks to Dr Kimmo Soramaki, Founder and CEO; and Dr Samantha Cook, Chief Scientist

Cambridge Architectural Research Ltd., with particular thanks to Hannah Baker, Graduate Research Assistant

Axco Ltd., with particular thanks to Tim Yeates, Business Development Director

Dr Andrew Auty, *Re: Liability (Oxford) Ltd.*

Antonios Pomonis, *Independent Consultant*

Dr Gordon Woo, *RMS, Inc.*

Cambridge Centre for Risk Studies

Website and Research Platform

<http://www.risk.jbs.cam.ac.uk/>

China-Japan Geopolitical Conflict

Contents

1	Executive Summary	2
2	Stress Test Scenarios	5
3	Geopolitical Conflict as an Emerging Risk	11
4	Scenario: China-Japan Conflict	18
5	Loss and Direct Impacts.....	24
6	Macroeconomic Analysis.....	32
7	Investment Portfolio	44
8	Managing the Risk	49
9	Bibliography	53

China-Japan Geopolitical Conflict

1 Executive Summary

Global conflicts

The 'Long Peace'

The Long Peace since the Second World War shows the changing nature of conflict, with growth of low-grade political violence, insurgency, asymmetrical warfare and civil war. The damage inflicted by conflicts on regions, nations and the global economy may be most visible in deaths and the mass movement of civilians fleeing violence, but also impacts trade and economic development. So it's no surprise that annual military expenditure is 2.5% of world gross domestic product.

We propose a scenario to quantify the effects of such a conflict catastrophe. Scenarios more generally can be used to cover the spectrum of extreme shocks. A suite of scenarios provides a basis for a global enterprise to stress test itself and improve its resilience to catastrophes.

China-Japan Conflict Scenario

The China-Japan Conflict Scenario imagines a situation where Japan and China carry out military strikes on each other, without provoking the military involvement of their allies. This clash follows an escalation of tensions over several months, driven by relatively minor events. Each nation uses air strikes to destroy the industrial and commercial facilities of the other in an apparent stalemate. The conflict is eventually ended by international intervention led by Russia and the United States.

Behind the China-Japan Conflict Scenario

Historical record and conflict studies

In the Long Peace it is difficult to imagine a major conflict breaking out. Surveys of people's risk perception suggest that the threat of interstate conflict is underestimated. Therefore a review of political science and conflict studies is used to identify a category of conflict that is plausible for modern political conditions, but severe enough to challenge assumptions about the status quo.

Scenario selection

The China-Japan Conflict Scenario was chosen over other candidate conflicts, such as Russian military adventurism, conflagration in the Middle East or a Korean war, which could inform the contingency

plans of risk managers. We don't explore an escalation that directly involves other nations.

Variants of the scenario

To see how the consequences of the scenario vary with our assumptions, we present several variants: a standard scenario (S1) where the conflict lasts nine months, one where the conflict lasts two years (S2), and an extended conflict of five years (X1).

This is a stress test, not a prediction

This report is one of a series of stress test scenarios that have been developed by the Centre for Risk Studies to explore the management processes of dealing with an extreme shock event. Beyond understanding impacts and responses around a specific shock, a suite of scenarios is needed to understand aspects of fragility of an organization and global system in which it sits.

An extreme, low-probability event

We describe a scenario of a military conflict that is unlikely to occur. In fact we have chosen a severity of scenario that we argue could only be expected to occur with a chance of 1-in-100 in any year. So there is a 99% probability that a scenario of this severity will *not* occur next year.

The unfolding scenario

The conflict develops in several stages over a period of nine months. Some key moments early in the crisis include a trade war, Chinese mobs storming Japanese factories in a district of Shanghai, and Japanese armed forces mounting a clandestine operation to rescue Japanese workers held hostage in Shanghai by Chinese activists. The first serious blow to major infrastructure is a cyber attack by China that causes failures in Japan's electricity generation and distribution system.

Air strikes

Shortly afterwards Japan initiates air attacks on Chinese military facilities and manufacturing infrastructure. China retaliates with air strikes on Japan's industrial facilities. Massive campaigns on both sides leads to a military stalemate. The conflict is brought to a conclusion by the United States and Russia jointly brokering a peace deal.

Impact on international trade

The scenario impacts the second and third largest economies of the world. The interdependency of global trade means that many other countries are affected as a result. The conflict creates exclusion zones for shipping and air travel, limiting the flow of trade between Southeast Asia and the rest of the world. Nearly half of the world's shipping traffic passes through the South China Sea and this is significantly reduced while the conflict continues.

Direct impacts

Human cost

The human cost is high, with 100,000 to 500,000 civilian deaths as a result of the strategic bombing campaigns against key cities in both countries. Many of these deaths are employees in commercial facilities. Millions more people are injured.

Property damage costs

Bombing results in extensive damage to physical facilities. Reconstruction costs are estimated at \$120 to \$500 billion.

Insurance losses

The insurance industry mainly excludes claims from war damage in its policies, so is not expected to have large property losses. It is however likely to pay claims from indirect consequences, for example in liability lines, life and health insurance, contingent business interruption, and in other lines where there are ambiguities around exclusion. Insurers need to ensure that their war exclusion terms are robust to avoid major losses.

Consequence analysis

The world's economy suffers from the shock waves of the conflict. Exports from China and Japan to other countries are severely reduced, along with their imports. We shock exports and other variables in the Global Economic Model of Oxford Economics to estimate global macroeconomic impact in terms of losses to global GDP output over 5 years.

There are many other side effects and systemic consequences – counterparty risk increases, and

more severe variants of the scenario trigger a financial crisis that causes a cascading failure of financial institutions and a liquidity crisis.

Lost global output of more than \$17 trillion

The conflict triggers a global recession, which persists over several years. The overall effect is measured in lost GDP output over 5 years ('GPD@Risk') ranging from \$17 trillion to \$34 trillion in the more extreme variant, the latter dwarfing the \$20 billion estimated loss of the Great Financial Crisis of 2007-2012.

GDP losses in the US and EU are substantial, in total \$5 billion, which is just shy of the \$6 billion damage that is jointly experienced by China and Japan.

Market impact

The standard China-Japan Conflict Scenario S1 hits the valuation fundamentals of equities and fixed interest bonds, with short term shocks to prices and longer term changes in interest rates and yields. A standardized high-quality, low-risk portfolio sees returns that are 20-50% worse than expected for 2.5 to 7 years. US, UK and Eurozone assets are associated with most of the losses.

There are two negative peaks, with portfolio returns relative to baseline of -80% and -100% in Year 1 and Year 5. Equities are responsible for the former negative peak and fixed income for the latter. Similar effects are seen for the scenario variants S2 and X1.

Risk management strategies

The scenario is an illustration of the risks posed by conflicts. Worse conflicts are possible, including the remote possibility of another world war.

This scenario aims to improve organizations' operational risk management plans around contingencies, and strategies for surviving the financial and counterparty challenges. It is presented as a capital stress test for insurers to consider their ability to manage underwriting losses while also suffering market impacts on their investment portfolios.

	S1	S2	X1
Conflict Duration Period (Market turmoil)	9 months	2 years	5 years
Export trade disruption period	1 year	5 years	5 years
Export trade loss during disruption	50%	70%	90%
Civilian Deaths	100,000	250,000	500,000
Civilians Hospitalized	230,000	575,000	1,150,000
Civilians with Minor Injuries	450,000	1,125,000	2,250,000
Direct Damage Replacement Cost	\$120 Bn	\$300 Bn	\$500 Bn
Total Insured Loss	\$40 Bn	\$90 Bn	\$150 Bn?
Lost GDP \$ ('GDP@Risk') Lost global output Year 1 to Year 5	\$17 Trillion	\$27 Trillion	\$32 Trillion
GDP@Risk (5 yrs) As a % of Global GDP at Year 0	30%	47%	56%
Investment Portfolio Impact (Relative to expectation baseline)	-20%	-35%	-50%
Duration of Degraded Returns	2.5 years	4 years	7 years
US Equities (Dow Jones) YR1Q2:	-432 bps	-744 bps	-1146 bps
UK Equities (FTSE) YR1Q2:	-126 bps	-204 bps	-306 bps
US Treasuries 2 Yr Notes, % Change	-0.027%	-0.024%	-0.020%
Exchange rate US\$ to £GBP YR1Q2	-2.22%	-2.17%	-2.17%
Inflation increase in US, YR3	-3.34%	-4.92%	-5.53%

Table 1: Summary of consequences of the China-Japan Conflict Scenario

2 Stress Test Scenarios

This report describes a plausible extreme future scenario and explores the effects that it would have. It is not a prediction. It is a ‘what-if?’ exercise, designed to provide a stress test for risk management exercises by companies who want to assess how their business systems would hold up under extreme circumstances.

This report is one of a series of stress test scenarios that have been developed by the Centre for Risk Studies to explore the management processes of dealing with an extreme shock event. Each individual scenario may reveal some aspects of potential vulnerabilities for an organization, but they are intended to be explored as a suite, to identify ways of improving overall resilience to surprise shocks that are complex and have many faceted impacts.

The scenarios have been designed in a number of ways. Firstly they are selected as plausible, but not probable, extreme events that would disrupt normal life and business activity. They are illustrative of the type of disruption that would occur with a particular category of ‘threat’ – i.e. a cause of disruption. In this example we explore the consequences of a geopolitical conflict disrupting daily life. Other threats considered in our suite of stress test scenarios include infectious disease pandemics, extreme weather events, cyber catastrophes and financial crises.

Complex risks cause macroeconomic impacts

These threats are of interest because they are complex risks – they impact the networks of activities that underpin the global economy, disrupting the interrelationships that drive business, and causing losses in unexpected ways and places. They have multiple consequences, in causing severe direct losses, but also operational challenges to business continuity, cascades of effects on counterparties and the macro economy in general, and on the capital markets and investment portfolios.

In these scenarios we explore how these effects might occur and try to trace the flow of consequences from initial losses to macroeconomic impact, and to market effects in the change of returns that would occur in a standardized investment portfolio.

The stress test is aimed at providing an illustration of the effects of an extreme event, to help a general audience understand the potential for events of this type to cause disruption and economic loss. It

is aimed at informing the risk management decisions of a number of different communities.

Use of this scenario by insurance companies

The insurance industry uses scenarios as stress tests for their risk capital assessments, with explicit return periods of capital adequacy required by internal management, or for regulatory or reporting purposes such as AM Best, Solvency II, Lloyd’s Realistic Disaster Scenarios, or other requirements. We offer this stress test scenario as a potential addition to the suite of scenarios that insurers may choose to use for their own internal purposes. The particular contribution of this work is the assessment of the correlation of potential underwriting losses with an investment portfolio loss, while also considering the operational risks that could be challenging the business at the same time.

Underwriting Risk	Operational Risk	Market Risk
Losses that could be caused to each insurance line in Life & Health, Property and Casualty.	Impact on operational functionality and continuity such as claims, distribution, personnel, counterparties	Impact on the investment portfolio of insurance asset management

For insurers, the scenario provides an indication of potential losses across different silos of risk

The scenario attempts to assess indicatively where losses might occur across a range of different lines of insurance underwriting. Where we have access to data on total insurance industry exposure we have attempted some indicative quantification of the potential order of magnitude of losses. Insurers interested in assessing the impact to their own portfolios can apply these loss ratios to their own exposure in these lines of business.

We have also estimated how the event would impact investment asset values, using a standardized high quality, fixed income oriented portfolio to show indicative aggregate returns. Investment managers could apply these asset values changes to their own portfolio structures to see how the scenario would potentially affect their holdings.

Risk capital models make assumptions about correlations between underwriting loss and market risk. This report explores how this correlation occurs and provides a detailed example for one scenario.

It does not provide a probabilistic view of this correlation, but it does provide additional variants to the scenario that act as sensitivity tests and indicative additional data points around the primary narrative.

The scenario is deterministic and is not designed to provide exceedance probability data points. It is very approximately selected to be in the range of the 1-in-100 annual probability of occurrence worldwide, but not rigorously determined.

Use of this scenario by investment managers

The scenario provides a timeline and an estimation of the change of fundamental value in assets in an investment portfolio. These are segmented into broad asset classes and geographical markets to provide indicative directional movements.



The scenario enables investment managers to optimize portfolio strategies against shocks

These provide insights for investment managers into likely market movements that would occur if an event of this type started to play out. In real events, market movements are chaotic and difficult to analyze. This analysis suggests how the underlying fundamentals are likely to change over time, due to the macroeconomic influences. Investment managers can expect this to be overlaid with a lot of noise and chaotic market activity.

The asset class differences and geographical distributions enable investors to consider how different portfolio structures would perform under these conditions and to develop strategies for portfolio management that will minimize the losses that might occur. Where there are obvious winners and losers by economic sector, these have been highlighted to provide inputs into optimal hedging strategies and portfolio diversification structures.

This report provides performance projections for a standardized high-quality, fixed income portfolio, under passive management. This is to enable comparisons over time and between scenarios. We also estimate returns for individual asset classes to help investment managers consider how this scenario might impact their particular portfolio and to consider the intervention strategies over time that would mitigate the impact.

Use of this scenario by organizations

Many companies use ‘what-if’ scenarios for understanding and managing risk. This scenario is designed to help organizations improve their operational risk management, and to identify improvements in business practices that will increase their resilience to shocks of this type in the future.

Stress test scenarios to improve risk preparedness have been well studied in management science. Scenarios that are most useful for improving operational risk management are those that are disruptive and challenging, and that force participants to confront a changed reality. It should challenge management assumptions about the status quo. For a scenario to be useful, it also has to be plausible (but not probable), and ‘coherent’ – i.e. everything in the scenario is consistent and interlinked.

Acceptance of a scenario can be a problem in implementing stress tests. It is natural for managers to challenge the assumptions of the scenario and to question how feasible it is. The actual details and severity metrics for the scenario is less important than the exercise of working through management actions, however this report includes a section explaining how the scenario was selected and the justification for the parameters of the scenario.

The scenario is selected to illustrate the severity of shock that can be expected from this particular threat type (geopolitical conflict) with around a 1-in-100 (1%) chance in any given year, so it is extreme but plausible. Our other scenarios are also selected at the same level of (im)probability. It is worth noting that the Centre for Risk Studies taxonomy of shock threats identifies over 50 potential causes of future shocks. Each threat type is capable of providing some level of challenging shock to parts of the world’s economy at around a 1-in-100 chance each year, so an organization could expect to experience, and have to manage through, one of these shocks on average every few years.

This scenario is presented as a narrative, with specific metrics of loss, impact, and disruption estimated as indicators of the levels of management challenge that would be faced. We try to make the narrative as realistic as possible, to help managers buy into the fiction for the point of view of exploring their decisions in this hypothetical situation.

Improving an organization’s resilience to a crisis requires a number of management elements, for which scenarios can be useful components. A major challenge is improving awareness of the potential for shocks and the expectation of

disruption. Many companies face the challenge of developing a risk management culture in their organization, where expectations of continuity of the status quo are properly challenged, and contingency planning is an evolving process.



The scenario is designed for organizations to improve operational risk management

Operational risk management involves a wide range of activities, including procedures and response planning under a wide range of potential conditions, and broader cultural issues such as measures to sustain institutional learning about risk, consideration of succession planning, shared value systems, incentives, reporting, governance, and management monitoring.

This scenario provides inputs into the contingency planning around a situation of exceptionally high absenteeism, disruption to the economy, failures of business counterparties, and disruption to global supply chains. It is intended to help companies improve their resilience to all future crises.

Use of this scenario by policy-makers

International agencies, national governments and local authorities consider scenarios for global and national security, public safety and welfare of the population. Studies of potential catastrophes are produced by agencies such as World Bank, World Health Organization, United Nations, World Economic Forum, OECD, and others to improve the awareness and decision-making ability of policy-makers. This scenario is proposed as an addition to that literature.

National governments create risk analysis frameworks and preparedness scenarios for civil emergencies. Examples include the United Kingdom National Risk Register for Civil Emergencies, and the Australian Government National Risk Assessment Framework. These frameworks commonly include example scenarios as guidance for local authorities in preparedness planning for deployment of emergency services and extreme response needs. In some cases,

performance reviews against classified versions of these scenarios are mandatory requirements for regional authorities.

This scenario is a contribution to the design of future versions of these policy-maker scenarios. It offers a view of the economic environment and broader business and social disruption that will be the context for the challenges of ensuring public safety and continuity of public services. It provides inputs into the decision making and resource planning of these authorities, and is offered as context for policy-makers concerned with disaster mitigation in general.

Understanding threats

This scenario explores the consequences of a key emerging threat type – geopolitical conflict – by examining the 1-in-100 severity of an international conflict with a selected example of how that severity could come about. For a truly resilient process, we would need to consider how other types of shocks might occur. It would include different severities and characteristics of other types and locations of conflicts. It would also include an appraisal of other types of threat that could cause shocks.

The Cambridge Risk Framework includes an attempt to categorize the potential threats of social and economic catastrophes, to provide a checklist of different potential causes of future shocks. This has involved a process of reviewing chronological histories for over a thousand years to identify all the different causes of disruptive events, collating other disaster catalogues and categorization structures, and researching scientific conjecture and counter-factual hypotheses, combined with a peer-review process.

Figure 1 provides the resulting Cambridge taxonomy of macro-catastrophe threats that have the potential to cause damage and disruption to social and economic systems in the modern globalized world. The threat taxonomy is hierarchical and categorized by causal similarity. The report *Cambridge System Shock Risk Framework: A taxonomy of threats for macro-catastrophe risk management* provides a full description of the methodology and taxonomy content.

The taxonomy provides a company with a checklist of potential causes of future shocks. It also provides a framework for collating information about these threats and populating it with more detailed studies of each threat. Threat types of particular interest are profiled with a stress test scenario like the one described in this report.

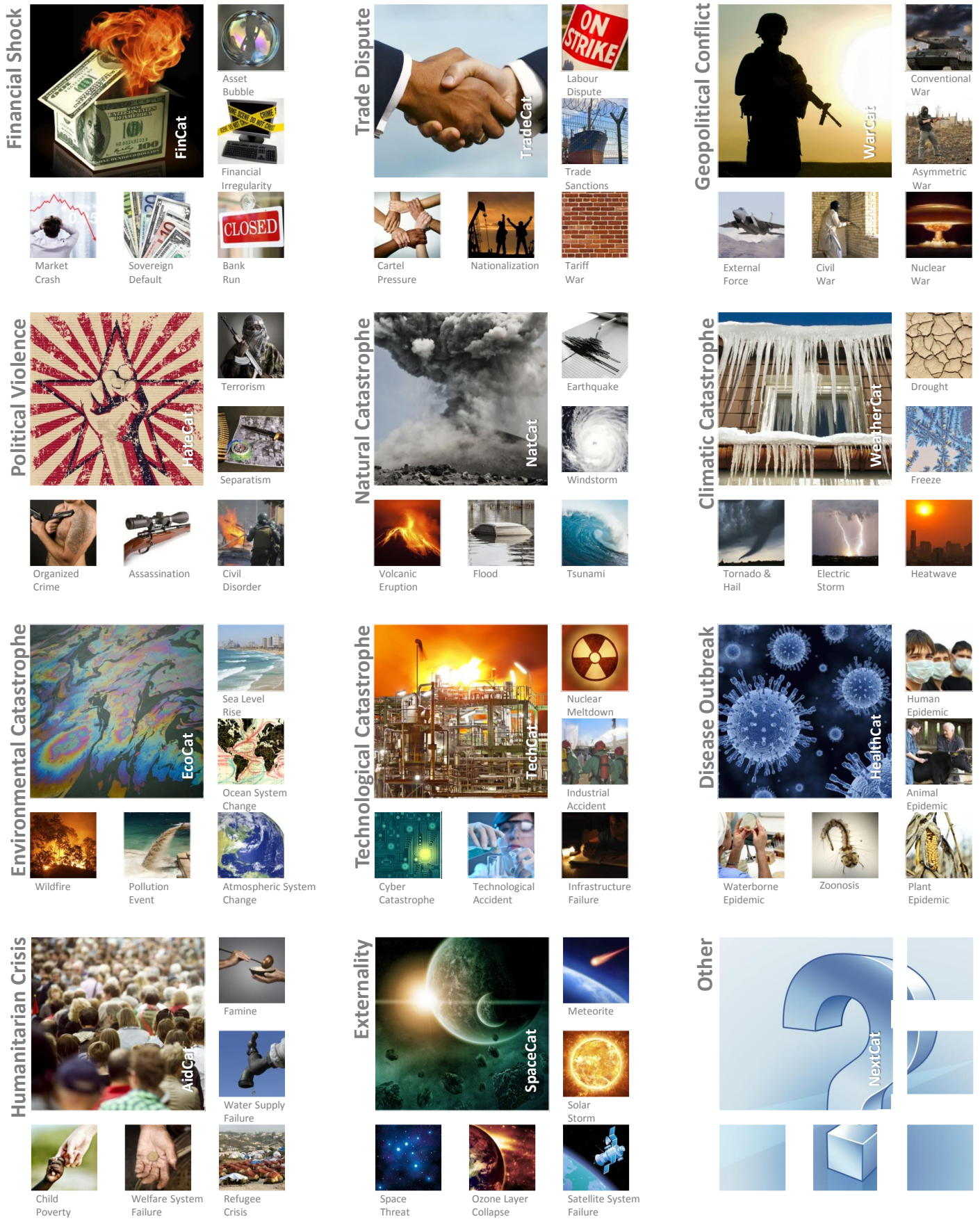


Figure 1: Cambridge Taxonomy of Threats provides a checklist for complex risks of concern to organizations

The taxonomy is being used to map the global landscape of complex risks, and to provide a suite of potential stress test scenarios that inform an organization's ability to withstand the wide range of shocks that it could potentially encounter. It is an aid to improving the resilience of an organization.

Developing a coherent scenario

It is a challenge to develop a scenario that is useful for this wide range of risk management applications. Fully understanding the consequences of a scenario of this type is difficult because of the complexity of the interactions and systems that it will affect. The economic, financial and business systems that we are trying to understand in this process are likely to behave in non-intuitive ways, and to exhibit surprising characteristics. We are trying to obtain insights into this interlinkage through using an extreme scenario.

Systemic instabilities constantly challenge our intuition, with many examples such as crowd behaviour, traffic congestion, financial crashes, power grid failures and others. These are examples of strongly coupled, complex systems that exhibit have unexpected behavior. In these systems we see patterns such as feedback loops; non-linear amplifications; control interactions; cascade effects; avalanche phenomena; threshold effects and regime shifts; emergent patterns of behavior; temporary stabilities; and equilibrium states. It is important to identify the potential for these scenarios to trigger these types of cascading consequences which are the main causes of catastrophic loss. These effects are what we mean when we call them complex risks. For stress tests to be useful, they need to be 'coherent' i.e. the described effects are all consistent with each other, follow causal mechanisms and logical consequence, and the correlation patterns of multiple impacts are represented comprehensively. The development of a coherent scenario requires structural modelling – i.e. scientific consideration of the cause and consequence sequence along the chain of cause and effect.

A structural modelling methodology

To develop a coherent stress test we have developed a methodology for understanding the consequences of a scenario, as summarized in Figure 2.

This involves sequential processing of the scenario through several stages and sub-modelling exercises, with iteration processes to align and correct assumptions.

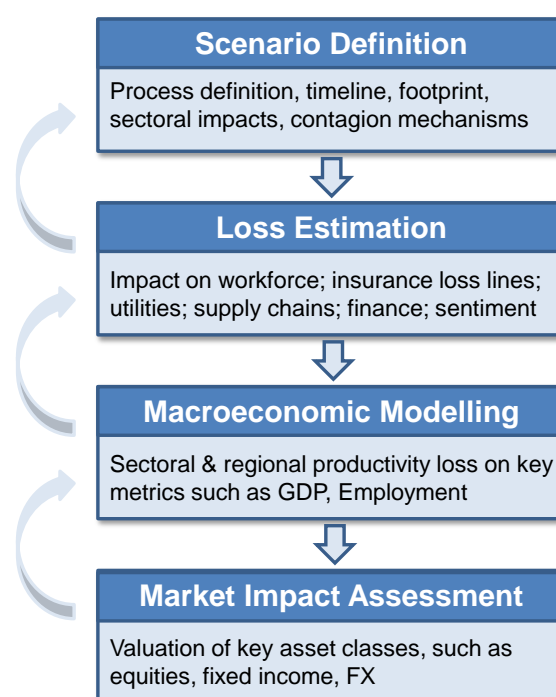


Figure 2: Structural modeling methodology to develop a coherent stress test scenario

The construction of a scenario using structural modelling techniques presents a number of challenges to fulfil the requirements for a coherent stress test.

The first challenge is can we construct an extreme fictional scenario that has never occurred before and make it plausible? We have attempted to do this through using evidence-based precedents, and detailed analysis of how similar events of the past would play out today, under current conditions.

Our second challenge is can these scenarios meet the criteria of being useable by businesses and ultimately adopted for use in risk management? To achieve this we have worked with key users to try to make these scenarios meet their management needs for stress test scenarios, and are actively seeking ways to get the scenario tested further and more broadly adopted.

Other challenges include can we estimate the losses that would result from extreme events that have not occurred in today's world? We have addressed this through using historical precedents and extrapolation from similar but less severe occurrences to provide an evidence-based approach to estimation.

We believe it is important to create a robust and transparent estimation process, and have tried to achieve this through detailed process of recorded assumptions made, and sensitivity tests about the relative importance of one input into another.

In the macroeconomic stages of the modelling, we are conscious that we are attempting to push

macroeconomic models, calibrated from normal economic behaviour, outside their comfort zone, and to use them in modelling extreme events. We have worked closely with the macroeconomic modellers to understand the useful limits of these models and to identify the boundaries of the models functionality.

A further test comes when we try to model the impact of hypothetical economic extreme conditions on investment asset classes and portfolios. We need to understand the limits of usefulness of assumptions such as asset value 'fundamentals' in investment performance estimation.

Uncertainty and precision

Overall the scenario consequence estimation process is steeped in uncertainty. The process entails making a number of assumptions, which feeds into a set of models to assess loss and direct impact. These are then used as inputs into a macroeconomic modelling exercise, with additional assumptions and the introduction of

considerable uncertainties and variation. The outputs of this then feed the assessment of portfolio performance, with additional assumptions and uncertainties.

In all the process is imprecise and one of compounded uncertainty from one stage to the next. The point of producing the scenario however is not about the precision of the consequence estimation. It is to understand the consequences in terms of their holistic effects, their relative severities and the patterns of outcome that occur. Linking all the components into a coherent scenario is difficult to achieve and the process described in this report is one approach that has attempted to do this. It is flawed, and acknowledged as such, but a useful exercise.

The scenario production process, limited as it is, does provide interesting insights, and many of the applications of the scenario are achieved through this imperfect approach. The scenario is offered as a stress test, to challenge assumptions of continuing status quo and to enable companies to benchmark their risk management procedures.

3 Geopolitical Conflict as an Emerging Risk

Armed conflicts litter the records of history. In the Centre for Risk Studies threat monograph on Geopolitical Conflict, we profile how conflicts have shaped society through history and current political science views on the threat they continue to pose¹.

Rank	Deaths	Conflict	Dates
1	40 - 72 million	World War II	1939-1945
2	15 - 65 million	World War I	1914-1918
3	5 - 9 million	Russian Civil War	1917-1921
4	2.5 - 5.4 million	Second Congo War	1998-2003
5	1.5-2 million	Afghan Internal War	1979-1984
6	1-2 million	Sudanese Civil War	1983-2005
7	1-3 million	Nigerian Civil War	1967-1970
8	800k - 3 million	Vietnam War	1955-1975
9	600k - 2 million	Soviet War Afghanistan	1980-1988
10	500k - 2 million	Iran–Iraq War	1980-1988
11	500k - 2 million	Mexican Revolution	1911-1920
12	400k – 4 million	Korean War	1950-1953

Table 2: Major conflicts in the 20th century, ranked by number of deaths caused.

Table 2 shows 12 conflicts in the past century that have each caused millions of deaths. Even the facts about these events are uncertain because of the great disruption and chaos that they cause. The 20th century was one of the bloodiest for conflicts, but by no means unprecedented. Studies of wars since 500 B.C. show that the most serious wars and atrocities – those that killed more than a tenth of a percent of the population of the world, have been pretty evenly distributed through the past 2,500 years of history².

However, the threat of war is not high on the risk assessment of many people. In surveys of perception of risks by industry and political leaders, conflict between nations tends to be low down the risk rankings³.

The Long Peace

The reason for this is that the period since the end of the second world war has been a lengthy period of peace, with no conflicts between major military powers, despite (or perhaps because of) major powers possessing nuclear weaponry that could inflict death tolls much higher than those achieved with conventional weaponry. This is known by

political historians as ‘The Long Peace’. It saw the world change from a cold war face-off between US and USSR, in which many commentators saw nuclear war as inevitable, to one of a single military super-power, the United States, policing a ‘Pax Americana’.

Many reasons have been cited for this, including the extension of democracy (democratic states rarely if ever go to war with each other); globalization and the inter-dependency of trade (it is economically too costly to go to war); education of the population and growing intolerance of political belligerence by their leadership; increasing acceptance of international law and more influential United Nations institutions that maintain peace; and the decreasing ‘business case for war’ in terms of gaining advantage from conflict.

Changing nature of modern war

And yet most nation states retain their capability for war, and the world still devotes 2.5% of its GDP on military expenditure⁴. Military spending worldwide today is at similar levels to the height of the cold war in 1988⁵, after a dip to the mid-1990s. Modest reductions in military spending by the West (mainly Europe) have been offset by rises in spending in the developing markets, Eastern Europe, and Russia. Nation states do not seem to assume that the threat of war has diminished, and they continue to see value in military expenditure to protect themselves against it.

The Long Peace period has not been conflict free. In fact records suggest that there may have been over a million deaths in at least 700 militarized conflicts in the past 25 years⁶. However the nature of conflict appears to have shifted during this period of the Long Peace, to one of insurgency, asymmetrical warfare, civil war, and low-grade political violence, rather than interstate military confrontation between major powers.

Political scientists are split between those who believe that violence is decreasing generally across society and argue that war is a permanently reduced threat⁷, and those who believe that a half century of low conflict activity is a phase that could end at any time⁸.

¹ Wallace et al. (2013). Centre for Risk Studies: *Geopolitical Conflict – Profile of a Macro-Catastrophe Threat Type*.

² Pinker (2011) p238.

³ In the 2014 Global Risk Perception Report derived from surveys of risk perception by more than a thousand participants, interstate conflict does not make the top ten, and is ranked below average in impact. (WEF 2014).

⁴ Stockholm International Peace Research Institute (2013).

⁵ SIFRI (2012).

⁶ Uppsala Conflict Database Program, University of Uppsala, from 1990. UCDP Conflict Encyclopedia.

⁷ A decreasingly violent society is argued by Pinker (2011) *The Better Angels of Our Nature*.

⁸ Sobek (2008).

Conflict theory suggests that underlying tensions rise and fall with shifts in the balance of power, and disputes arise that provide the conditions for a potential conflict, but that common sense often prevails and the cost of a prospective war is usually sufficient to force antagonists to come to a peaceful resolution. Overconfidence and ‘positive illusions’ can trigger wars: “opponents rarely go to war without thinking they can win, and clearly one side must be wrong – this conundrum lies at the heart of the ‘War Puzzle’: rational states should agree on their differences in power and thus not fight”⁹.

Random chance may also account for the difference between a tense situation escalating into a conflict, rather than defusing through negotiation. Statistical analysis of intervals between wars (and the duration of wars) suggests that starts and ends of wars are consistent with observations of random processes¹⁰ – wars often start by accident. The Long Peace could be as much about chance not having given rise to a war trigger event as there being a reduction in the underlying tensions and motivations for war.

Other theories suggest that periods of hegemony – one dominant military power – are associated with periods of peace, but that when the world order is threatened, such as a new challenger to the superpower, the likelihood for conflict increases. In this interpretation, the United States dominance that has ensured a half-century of low activity rates for conflict, could be entering a new period of challenge from China and possibly from a resurgent Russia. The chance of a conflict may be increasing again as regional powers seek to challenge and define a new world order.

What is an appropriate stress test scenario?

For business risk managers, the issue is one of appropriate threat assessment. Has the threat of disruptive war changed forever and it can be permanently discounted, or does it remain a risk that should be included in contingency planning? If it is a risk that should be incorporated into business planning, then what would be an appropriate stress test to use for planning purposes?

In the stress test scenarios of different threats being developed by the Centre for Risk Studies, we try to assess the magnitude of each threat that might be expected with a 1% annual probability of exceedance (the 1-in-100 chance) for the world as a whole. This defines the severity and a scenario is developed to illustrate an example of that severity.

⁹ Johnson (2004).

¹⁰ Richardson (1960) shows that the timing of wars is ‘Poissonian’ – consistent with a random roll of the dice each year.

For geopolitical conflict, the issue is what severity of conflict should we expect worldwide with a 1% annual probability of exceedance? Can we do this in an evidence-based way?

Statisticians have observed from the statistics of deadly quarrels¹¹, that like many types of catastrophes, the ranked distribution of size of wars conforms to a power law – there are a lot of small wars, and only a few large wars and their ratio follows a logarithmic progression.

What is a “1-in-100” conflict?

If we were to take the past century as our benchmark – the long term view of war risk – then a 1-in-100 scenario would be a global conflict. There have been not one but two world wars in the past hundred years, each causing tens of millions of deaths. However, we do not advocate using a world war as a useful stress test for business purposes – this ignores the current reality of a sustained peace.

However, if we were to take the recent more peaceful period as our benchmark – the short term view of war risk – and take the ranked distributions of deaths in conflicts that have occurred since 1990 and extrapolate the distribution to the 1% annual probability of exceedance, it suggests 100,000 to 250,000 deaths as the appropriate severity of conflict to consider. However it may be that a relatively minor conflict occurring in a remote location may not be a sufficiently severe test to challenge current complacent assumptions about the potential for a more disruptive conflict than managers have experienced in recent memory.

In this section we explore conflict theory to provide a categorization of conflicts and a magnitude scale, from 1 to 5. We propose that a conflict of magnitude 3 – a regional war between one of the three predominant military powers and a lesser ally of another power – is the appropriate ‘what-if’ scenario, providing a sufficiently severe impact on the global economy to use as a stress test, without becoming implausible for management acceptance.

Preparing for the possibility of a war remains a challenge for business managers. It is certainly difficult to imagine the end of the prosperous peace that we have come to expect. It is difficult for rational people to imagine the occurrence of a war – and has always been: “In 1914, Europe sleepwalked into a war that no one expected.”¹²

¹¹ First observed by Lewis Fry Richardson in 1960.

¹² Clark (2013).

Conflict Definition

Conventional conflict is a contested incompatibility, which concerns government and/or territory where the use of armed forces between two parties, of which one is a government of a state.

Studies of global risks

During the period of ‘Pax Americana’, the world has experienced a relative degree of peace. Comparatively, there have been few instances of interstate conflict since and no major power war has erupted since 1939, constituting the longest era of major power peace during the past five centuries. This can be largely attributed to the spread of democratisation and increased connectivity spurred by globalisation. In a unipolar world, however, we have still seen a number of significant wars, and assessing this period of unipolarity against past periods of multipolarity and bipolarity helps elucidate the patterns of warfare in each phase. This is particularly relevant as the world enters a period marked by the rise of new powers, led by China, who will challenge the hegemony the US has enjoyed over the last half a century.

The causes of war are not only complex - both multi-causal and multi-faceted - they also change over time. Such changes are best understood using a framework of the distribution of power within the international system.

Balance of power

Distribution of power plays an important role in determining the patterns and probability of warfare and is best expressed in degrees of polarity (the concentration of power within the international system)¹³.

Bipolarity

Bipolarity is the distribution of power in which two states are roughly symmetrical in their economic, military and cultural influence (e.g. the Cold War). Two major concepts characterise bipolarity: power distribution and alliance clustering. The two components have ‘opposite’ effects on warfare in an international system – while bipolarity minimizes the magnitude of those wars that do emerge; alliance bipolarity increases the likelihood of warfare itself.

During a bipolar period an increase is likely to be seen in offshore balancing and proxy wars as the

superpowers utilise their alliances in an attempt to mitigate the threat of the opposing superpower. However, the symmetrical distribution of power and remnants of mutually assured destruction created an appreciation of the consequences of direct action and the risks and likelihood of escalation.

Unipolarity

Unipolarity is a system in which one state has significantly more capabilities than any other, and renders the possibility of world war less likely, as no state, and no (plausible) coalition can threaten the security of the superpower, and thus war is no longer a viable channel to challenge the superpower. However, while the superpower may have the ability to intervene and limit other wars, its decision to do so will depend on its values and outlooks, alongside the behaviour of other actors in the international system.

Driving factors

Competition for resources and economic growth

Since the Peloponnesian wars, conflicts have often focused on the acquisition of natural resources. Conflict between two states is more likely when at least one country has natural resources (and is disproportionately higher when oil is involved), and when these natural resources are closer to the border.

Political

Rallying the public against a common, foreign enemy has proved to be an effective political tactic. Between 1946-76 it is estimated that US Presidents deployed 214 military units abroad for political purposes, often with the aim of bolstering domestic support. Economic context, the position in an electoral cycle and relative power abroad are all likely to affect the decision to resort to war to generate political kudos.

Ideology

Ideology, whether political, cultural or religious, is a common justification of/for war, and has a particularly important role in less democratic countries, where limited structural legitimacy is supplemented with strong ideological messages. Certain ideologies are also more conducive to warfare than others. Authoritarian regimes espousing expansionary nationalist ideologies, that propagate a worldview, often see war as a necessary means of putting vision into practice.

¹³ Frank Wayman (1984), “Bipolarity and War: The role of capability concentration and alliance patterns among major powers, 1816-1965”, *Journal of Peace Research* 21(1), pp.61-78

An era of Pax Americana

Fukuyama¹⁴ observed that while the 20th century had seen the world descend into a ‘paroxysm of ideological violence’ it was closing with an unabashed victory for economic and political liberalism. The emergence of the U.S. as the dominant superpower in the aftermath of the Cold War ushered in an unparalleled wave of globalisation. Of which, three related tenets have been central in shaping the contours of conflict: the spread of democracy; economic interdependence; and international institutions.

Democracy may make the world more peaceful

The spread of democracy and democratic principles has profound implications for the onset of conflict. It is argued that two democracies will never go to a war with one another. From a normative perspective liberal capitalism sponsors a culture of contracts in which individuals and nation-states prefer bargaining to coercion or conflict.

Economic development and interdependence

Democratisation has ushered in an era of greater economic development, which reduces conflict propensity as increased economic interdependences provide incentives to avoid any trade disruption. It can, however, also increase tensions as the thirst for natural resources and energy grows in tandem with economic prosperity.

International Institutions

International Institutions play a key theoretical linkage in democratic peace theory. They encourage peace through socialization, enforcing credible commitments and dispute settlement. While empirical results for the efficacy of International Institutions are mixed, international institutions composed of democracies are shown to have a robust relationship to peace promotion.

Future trends: shift to multipolarity

The geopolitical landscape is changing, with a noted decline in the relative economic and political power of the US. As the era of US unipolarity diminishes, we are likely to see diffusion of power amongst states, individual empowerment and the rise of non-state actors, often facilitated by technological innovation.

¹⁴ Francis Fukuyama (1989), ‘The End of History?’, *The National Interest*, pp. 3-18

Failure of Bargaining

Ultimately, it is individuals who make the decision to go to war. Assuming that both parties are rational, it is argued that there must be reasons, which prevent a mutually advantageous and enforceable agreement¹⁵:

1. Asymmetric information about the potential costs and benefits of war.
2. A lack of ability to enforce a bargaining agreement and/or a lack of the ability to credibly commit to abide by an agreement.
3. Indivisibilities of resources that might change hands in a war, so that not all potentially mutually beneficial bargaining agreements are feasible.
4. Agency problems, where the incentives of leaders differ from those of the populations that they represent.
5. Multilateral interactions where every potential agreement is blocked by some coalition of states or constituencies who can derail it.

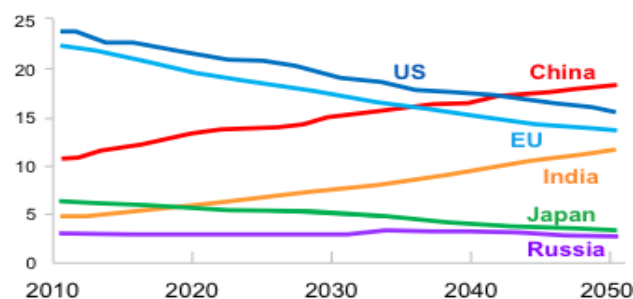


Figure 3: NIC Forecast of global power index trends¹⁶

A corollary of growth of non-OECD nations is the issue of access to key resources – minerals as well as energy – which are critical to continued economic growth. The potential for disputes to flare up over these issues will increase and seabed rights, in particular, is a pertinent issue across several regions, notably in the South and East China Sea, where tensions continue to simmer between China and its neighbouring countries.

Magnitude scale

Through the development of a comprehensive historical catalogue, and detailed analysis of several examples (see *Threat Monograph*:

¹⁵ James Fearon (1995), ‘Rationalist Explanations for War,’ *International Organization* 49(3), pp. 379-414

¹⁶ National Intelligence Council, *Global Trends 2030: Alternate Worlds*, <http://globaltrends2030.files.wordpress.com/2012/11/global-trends-2030-november2012.pdf>

Geopolitical Conflict for more information), a simple magnitude scale has been derived to classify the various types of war. The scale is based upon a number of factors (e.g. size of belligerents, length of conflict, casualties, disruption, economic and social impact, etc.), and ranges from one to five.

Conflict magnitudes

Magnitude 1 Conflicts are relatively frequent and are generally limited in their social, economic and political impact at a regional and global level. They are limited in their modes of warfare and geographic scale and have primarily been fought for economic or political reasons, and are characterised by a roughly symmetrical, and relatively low, distribution of power between belligerents.

Magnitude 2 Conflicts occur less frequently but often with widespread economic, political and social implications. Ideological and political motivations have been the source of the recent US-led invasions of Iraq and Afghanistan. Although such invasions are characterised by an asymmetrical distribution of power, they have also to protracted conflicts through the application of insurgency/guerrilla style warfare.

Wars between two tier 2 countries have been driven primarily by economic and political factors in the 20th Century (e.g. Iran-Iraq, Egypt-Israel & India-Pakistan). These wars are more likely to occur and continue during periods of bi- or multipolarity. While relatively minor countries, if they are producers of a particular commodity, there can still be significant ramifications for the global economy (e.g. the Iraqi burning of Kuwaiti oil fields saw the price of oil jump by 60% in just over 10 weeks).

Magnitude 3 Conflicts involve the major industrialized nations of the world: nations with a Military Power Index of above 1.5¹⁷. Since the formation of the G20 there has yet to be a regional war between a superpower and a G20 nation. However, conflicts earlier in the 20th century, notably the Russo-Japanese War and the Second-Sino Japanese War have both been considered 'Great Wars' with significant global ramifications. The Second-Sino Japanese War was the longest conventional war of the 20th century and came at a huge human and economic cost: there were 15-20 million casualties and both economies lost tens of billions in due to physical damage and lost production.

Magnitude 4 Conflicts are extremely rare due to the number of nations involved and the scale of the devastation caused. Despite the occurrence of two Magnitude 4 wars in the 20th century, World War I, with an estimated cost of c.US\$ 340 trillion, and World War II, which wiped out approximately 2.5% of the world's population, the emergence and development of globalisation, economic interdependencies, and social connections, the prospects of a future world war are thought of as being extremely unlikely.

Magnitude 5 Conflicts would be the exchange of thermonuclear weapons between superpowers. The threat of nuclear war has never been greater than during the Cold War, where, ironically, it was the principles of MAD (Mutually Assured Destruction) that acted as a key defense mechanism, preventing armed conflict between the Soviet Union and the United States.

Selecting the scenario

In selecting a scenario to develop, we assessed the current state of global tensions against the capacity for achieving a magnitude three conflict. A number of candidate locations and causes were considered, including:

- A potential conflict in the Middle East
- A conflict involving Russia and an Eastern European neighbour or European ally
- A conflict between North and South Korea, backed by their allies
- Other flashpoints that may arise in other countries from time to time

The scenario of a conflict between China and Japan was selected as a stress test scenario because of the severity of likely consequences. It was of particular interest because of the increased likelihood of a transition from a unipolar world to a bi- or multi-polar one. China is the most obvious challenge to US supremacy; its thirst for natural resources, and authoritarian political system make it a plausible belligerent.

The disputes over islands in the South and East China Sea have created an underlying tension with the Philippines, Vietnam, and Japan. Japan is another G20 country, with a huge reliance on imported energy, and is supported explicitly by the US. There is a history of war between the two countries and strong nationalistic rivalries. Although China is much larger by size and population, there is approximate symmetry of economy and industrialisation. Similarly, both countries are important, globally connected nations and any conflict would take place in one of the busiest shipping lanes in the world.

¹⁷ Military Power Index assessments produced by Global Fire Power www.globalfirepower.com

A war scenario between China and Japan is plausible, albeit unlikely, and would have profound effects on the global economy.

Military participants in the conflict

The relative military strengths of potential participants in a regional conflict of this type is presented in Table 4. Close allies and protection pacts are shown, but this does not indicate that we assume that they become militarily active in the conflict. Our scenario assumes that only China and Japan engage in hostilities. A key factor in the magnitude of this conflict is whether the United States would engage in military action against China in support of its formal defense pact with Japan. We have assumed that it does not. In our scenario, Japan ignores US calls for caution and takes what might be perceived to be an early aggressive act, to which the US administration responds by playing a peace-broker role, rather than a belligerent one.

There are of course scenarios that can be envisioned where the conflict escalates further and involves military participation by many of the regional powers identified in Table 4. In our conflict magnitude scale this would entail escalation into a magnitude 4 conflict.

We have chosen to limit this study to a magnitude 3 conflict.

Scenario variants

The scenario includes a number of variants that have been included to provide sensitivity analysis around the assumptions being made.

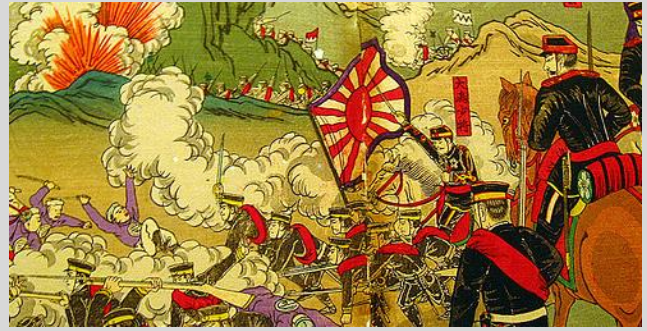
Standard Scenario S1 consists of 9 months of conflict before stalemate occurs and intervention enables peace to be concluded.

Scenario Variant S2 is similar to the standard scenario, but the conflict period lasts 2 years, with trade disruption continuing for a further 3 years. An important aspect of the macroeconomic consequences is the duration of the disruption to international trade. *Phase 4* is prolonged, with double the economic losses and around 250,000 people dead.

Scenario Variant X1 (Extreme 1) is the most severe variant considered in the impact analysis. Conventional weapons are still preferred but the conflict lasts over 5 years, causing over 3 times the losses and nearly 500,000 deaths. Such a variant plunges the world into a three-year recession after 90% of export trade is lost.

Precedent Case Study

Previous China-Japan Conflicts



A key criterion for selecting a China-Japan conflict for this scenario is the history of war between the two nations.

First Sino-Japanese War, 1894-5

Having retired its isolationist policies in 1853, Japan underwent a period of rapid industrialisation and social reform and by 1882 had set its sights on imperial gains in Chinese-controlled Korea. In 1894, a diplomatic clash over actions taken to put down revolt in Korea provided the catalyst of the First Sino-Japanese War. China suffered an overwhelming defeat, allowing Japan to seize strategic territory and become the dominant political power in Asia.

Second Sino-Japanese War, 1937-45

In the aftermath, China suffered internal conflicts between nationalist and communist political parties, while the Japanese continued to expand into Chinese territories. In 1937, a skirmish at Luguo Bridge between national forces led to an outright Japanese invasion of Northern China which came to an end only with the Allied victory in the Pacific theatre in 1945. The Second Sino-Japanese War was characterised by vicious 'scorched earth' tactics and civilian massacres in the urbanised north. Most notable is the 'rape of Nanjing' which saw 200-300,000 Chinese civilians executed and 20-80,000 women raped between 1937-8. Civil war persisted in China following the conflict, leading to the Chinese Communist Revolution and the ascension of Mao Zedong in 1949. In all, the Second Sino-Japanese War claimed an estimated 20 million casualties, caused \$383 billion worth of property damage, and led to defaults on \$250 million worth in loans with the Farmers' Bank of China.

Today, the memory of both wars persists as a major obstacle to future Sino-Japanese relations and a point of great cultural contention between China and Japan.

4 Scenario: China-Japan Conflict

Scenario background

There are many disputed islands between China and Japan (for example, Longjing/Asunaro; Tianwaitian/Kashi; Duanqiao/Kusonoki). The most well-known are the Diaoyu/Senkaku Islands, equidistant from Taipei and Ishigaki (170km). Japan controlled the uninhabitable islands since the first Sino-Japanese war in 1895, leaving them to American administration per the post-war occupation of Okinawa. Since the discovery of oil and other natural resources in 1968, both China and Japan have disputed sovereignty over the islands, and thus the boundaries of their Exclusive Economic Zone (EEZ) – the UN Convention of the Law of the Sea (UNCLOS) prescribed seazone giving states special rights over the marine resources within a 200 nautical mile perimeter.

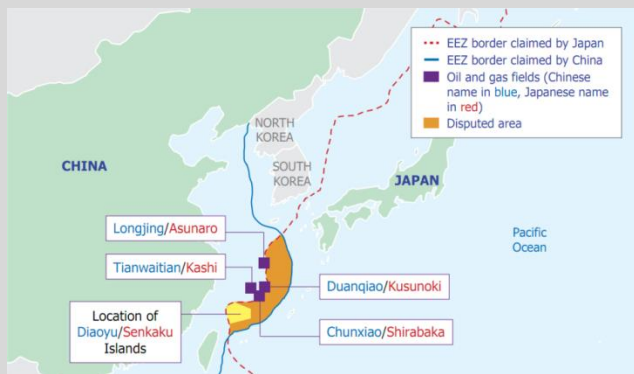


Figure 4: Disputed islands in the East China Sea;
Source: U.S. Energy Information Administration.

The islands have grown in importance and strategic significance, both militarily (for coastal defence) and economically (in terms of natural resource value, and as key trading and shipping routes). Aside from their physical and symbolic importance to China and Japan, the proximity of the islands to Taiwan and their position in the East China Sea puts them directly in the main shipping routes from the South China Sea to South Korea and Tianjin.

Phase 1: escalating tensions

Naval manoeuvres, large-scale war-games, and diplomatic posturing have defined recent tensions. Amidst military modernisation, increased Chinese nationalism, the legacy of conflict (the Sino-

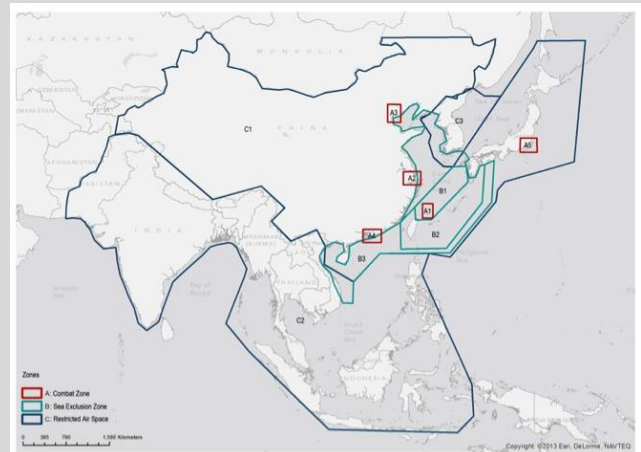


Figure 5: Map of the conflict scenario, showing conflict areas, sea exclusion zones, and restricted air space.

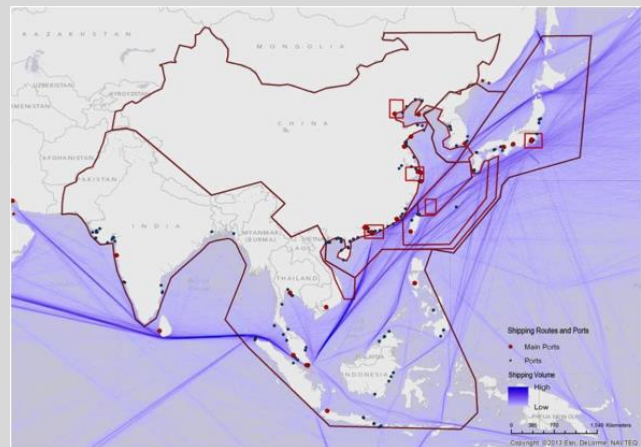


Figure 6: Conflict Zones affecting shipping lanes in East Asia

Japanese wars) and an extreme thirst for natural resources, China and Japan have continued to clash over the islands. As Japan imports 90% of its energy, it is eager to maintain an open and free flow of maritime trade¹⁸ but despite bilateral trade reaching US\$ 345 billion, China is pursuing a more assertive position, fuelled by nationalism and a rise in anti-Japanese sentiment. Since Japan's nationalisation of three of the disputed islands, China has increased the frequency and scale of incursions, for example, Chinese aircraft have entered the disputed airspace and Chinese frigates have engaged Japanese destroyers. Tensions have reached their highest level since the end of World War II.

¹⁸ Storey, Ian. "Japan's Growing Angst over the South China Sea", ISEAS Perspective, Institute of Southeast Asian Studies, Singapore

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Tensions grow in East China Sea

Near miss near disputed islands prompts another diplomatic row

Wednesday, January 8

Tokyo, Japan (2103 GMT – 0503 JST) - **Tensions between China and Japan grew yesterday following a skirmish at sea between Japanese fisherman and China's People's Liberation Army Navy.**



Set against a backdrop of military modernisation, increased Chinese nationalism, the legacy of the second Sino-Japanese war, and an extreme thirst for natural resources, China and Japan have continued to clash over the islands.

Naval manoeuvres, large-scale war-games, and diplomatic posturing have defined recent tensions. The most

Japanese and Chinese coast guards were quickly on the scene but did not engage one another

recent clash saw Japanese fishermen stray into Chinese waters when fishing near the disputed Senkaku/Diaoyu Islands. China's Navy fired on the boat, although no injuries were reported from either side.

In a show of self-determination, Japan's Diet passes new laws that repeal limitations of the Constitution on use of military force to settle international disputes¹⁹.

There is growing concern that the situation in the East China Sea will soon escalate beyond the disputes in the South China Sea, where the Chinese navy attacked commercial Vietnamese vessels over proximity to the Spratly Islands²⁰. A Japanese fishing vessel is fired upon after straying into Chinese waters. Although the crew of the damaged boat returned safely, angry diplomatic exchanges begin from the highest levels of both governments. Japan acknowledges the error of the fishing boat and promises immediate action to prevent further incidents²¹. Although tight-lipped at first, details emerge that the Japanese deployed naval engineers to install radar equipment on the disputed islands to 'help ships and boats navigate the area safely'. The Chinese government and state-run media react angrily to the news, stating that the objective of 'preventing marine accidents' is a 'thinly veiled attempt to disguise an egregious, unlawful and dangerous attempt to claim sovereignty over the islands'.

Phase 2: provocation and posturing

Stocks tied to Japanese businesses suffer heavy losses on Chinese stock markets as tensions increased amid uncertainty over the Chinese response. Although expected to call for a UN Security Council meeting, the Chinese government bypass diplomatic protocols and issue a public condemnation and ultimatum, demanding that Japan remove immediately the radar and personnel within 72 hours. Failure to do so, the statement continues, will be considered "an unacceptable act of aggression against Chinese sovereignty". Despite international calls for calm and volatility in global stock markets, Japan refuses to remove the radar equipment, reiterating their "honest and responsible intent to protect all in the East China Sea".

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Crisis Point in East China Sea

China blames Japan for 'deliberately provocative action'

Thursday, February 13

Beijing, China (1129 GMT – 1829 CST) - **Chinese politicians launched a stinging attack on Japan's 'deliberately provocative actions', following new of Japan's installation of radar equipment in the disputed Senkaku/Diaoyu Islands in the East China Sea.**



Japan maintain the radar unit will improve safety in the area for all vessels following a number of close calls with China's military. Chinese officials have dismissed their rational, arguing that it is 'an egregious, unlawful and dangerous claim for sovereignty.

The international community has pleaded for calm, with US officials reluctant to state whether it was prepared to support Japan militarily if the crisis escalated.

The disputed islands play a significant role in determining each countries Exclusive Economic Zone (EEZ).

¹⁹ *Kyodo News International*; March 3, 2014; 'Japan eyes revising current laws to enable collective self-defense'.

²⁰ Storey, Ian. "Japan's Growing Angst over the South China Sea", ISEA S Perspective, Institute of Southeast Asian Studies, Singapore

²¹ "Senkaku air intrusion prompts radar upgrade", December 15 20102, Japan Times, <http://www.japantimes.co.jp/news/2012/12/15/national/senkaku-air-intrusion-prompts-radar-upgrade/#.Ugz9oxapBYI>

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Markets panic as China offers ultimatum

FTSE (-3.2%) and Dow (-3.7%) plummet amidst fears of war

Friday, February 21

New York, NY (2251 GMT – 1751 EST) - Financial markets tumbled around the globe as fears grew of armed conflict between China and Japan. China's ultimatum requires Japan to remove all equipment and personnel within seventy-two hours. Failure to do so, Chinese officials state, "will result in swift and appropriate military action".



Traders suffered heavy losses following announcement of China's ultimatum and suspension of trade.

It is understood that China are not pursuing diplomatic solutions following removal of all non-essential personnel from their embassies in Japan. Compounding fears of war and triggering large drops on markets worldwide, China suspended all trade agreements with Tokyo.

Anti-Japanese protests have been on-going in all of China's major cities. Western countries have urged citizens to avoid the region completely.

After 24 hours, China orders an immediate cessation of all trade import agreements with Japan and issues a travel advisory, warning all citizens to leave Japan immediately. The United States and several EU nations urge calm. The Dow Jones and FTSE100 are among many global markets that suffer heavy losses on fear of war and the implications for long-term economic growth.

The world waits anxiously for the deadline. Rumours of negotiations excite the press and prop up the markets but the sudden and conspicuously coordinated departure of all non-essential personnel from the Chinese embassies and consulates in Japan prompts widespread pessimism.

Many international operations decide to withdraw executives from their offices in key cities in the region.

Phase 3: military incidents

Seventy-two hours after the ultimatum, a Chinese People's Liberation Army Navy (PLAN) *Lanzhou*-class destroyer launches a C-602 cruise missile against the radar installation on the disputed islands. The missile destroys the radar along with a naval transportation unit, killing 18 members of Japan's Maritime Self-Defense Force (JMSDF). The West condemns the missile attack with US, UK and France calling an urgent meeting of the UN Security Council.

Japan's population is outraged and the Japanese government publicly promises retaliation. The US government urges restraint on Japan and warns that any proactive Japanese actions to provoke China could compromise US ability to support them in future actions.

Stock markets plummet as fear of war sets in, with commodity prices, particularly oil, increasing significantly.

The following evening two Japanese Mitsubishi F-2 fighter planes from Tsuiki Air Base in Fukuoka, armed with ASM-2 anti-ship missiles, destroy the Chinese ship responsible for the attack on Senkaku. China news agencies report 37 sailors killed in the attack, with the destroyer afloat in open water but damaged beyond repair.



Figure 7: Japanese F-2s

Protestors take to the streets in China opposing Japan's attacks. Japanese populations are jubilant, with nationalistic media coverage. The wider international community condemns the retaliation.

China instigates a full blockade of Japanese vessels travelling through the Taiwan Strait and South China Sea, while promising safe passage for all non-Japan bound ships; they close their airspace to planes coming to or from Japan. Japan reacts similarly, restricting movement of Chinese ships and planes. To prevent any attempt on the part of JMSDF to access the islands, Chinese PLAN enacts a familiar mine warfare strategy to block access.

The 'Elfreida', a commercial US\$200m Ultra Large Container Vessel travelling from Busan in South Korea to Singapore, is lost at sea along with nearly 15,000 TEUs (twenty-foot equivalent units) of cargo. Although the cause is not confirmed, speculation mounts that the ship struck a Chinese mine that had drifted into open water. Japan is quick to label it as another act of recklessness, while China blames a Japanese submarine attack for the disaster.

Amidst the high level of tension, another civilian disaster occurs as a commercial aircraft carrying 400 passengers disappears. A 747-400 heading from Beijing to Sydney disappears from the radar.

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Japan denies shooting down Flight 583

Beijing to Sydney passenger plane crashes near Japan; 403 dead

Tuesday, March 25

Sydney (2308 GMT – 0808 Aus EST) - **A full military air and sea blockade is in force after a Beijing Air 747-400 disappeared from radar shortly after entering Japanese airspace.**



Wreckage of the plane, which was travelling from Beijing to Sydney, was found near the Japanese coast line. All 403 passengers and crew are presumed dead. Japanese officials have denied responsibility following China's accusations that a surface-to-air missile brought down the airliner.

The disaster comes only days after an 'Ultra Large Container Vessel' travelling from Singapore to Busan (South Korea) sank outside the restricted zone. Japan accused China of targeting the vessel, which the Chinese denied vehemently.

Anti-Japanese protests have escalated following the crash

Recent speculation suggest that a Chinese mine, broke its mooring and drifted into open sea.

The downing of the Flight 538 has led to widespread protests against Japanese people and businesses in China. Several people have been killed in intense anti-Japanese and anti-Western rioting in Shanghai and Beijing.

more Japanese workers are taken hostage by protestors.



Figure 8: Senkaku/Diaoyu Islands – the key territorial flashpoint of the China-Japan conflict

Phase 4: All-out conflict

Japan's Special Forces mount a clandestine operation to rescue the Shanghai hostages, bringing commandoes ashore and into the factory compound in central Shanghai, undetected by Chinese defense forces. The operation successfully extracts the Japanese hostages, and the Japanese Special Forces escape before the Chinese army can react, but several Chinese protestors are killed.

China responds with a subtle but devastating response. A cyber attack shuts down Japan's Futtsu Power station, near Tokyo, the second largest gas power station in the world and key provider of energy to the Keihin and Keiyo Industrial Zones, which form the largest industrial region in Japan²⁵.

The attack cripples Japan's industrial sector and denies power to military bases in the region. Power shortages restrict industries to three-day weeks as Japan starves for energy.

At the same time, in the United States, Washington D.C. suffers a mysterious but temporary power cut. Despite China denying responsibility for computerized hacking of the US power grid, military commentators interpret it as 'virtual shot across the bow', to warn the US away from military intervention.

over the East China Sea²². Accident investigators cannot determine that it was destroyed in an act of war. Aside from the human cost, insurance claims are expected of up to a billion dollars²³.

United States, India and Australia create a total blockade of the East China Sea. Ships travelling from Japan are forced to travel south of the Philippines, increasing journey times by over 30%. South Korea trade routes with Asia and Europe are also severely affected, however, as it is summer, trade with Europe suffer less, as they can use Arctic-shipping lanes and actually reduce shipping times by almost one week²⁴.

China's imports and exports are hit hardest. Their cross-Pacific journeys are rendered almost impossible, severely hampering trade and diplomatic relations with the United States.

Chinese citizens take to the streets in protest. Although protests are generally anti-Western, they are particularly focused on anti-Japanese protests. Japanese businesses are ransacked and burned, and Japanese commercially branded products destroyed on the street.

A Japanese factory in Shanghai is stormed by an angry mob, killing Japanese managers. Dozens

²² Similar instances include flight KAL 007, shot down in 1983, and Iran Air flight 665, shot down in 1988

²³ Frye, Andrew, "Air France Crash May Be Most Expensive Since 2001 (Update)", Bloomberg, June 10 2009, <http://www.bloomberg.com/apps/news?pid=newsarchive&sid=arLJ560WUeSk>

²⁴ Lim b, Jae-Un, *Korea gains permanent observer status on Arctic Council*, May 21 2013, <http://www.korea.net/NewsFocus/Policies/view?articleId=108026>

²⁵ Ministry of Foreign Affairs, Japan (<http://web-japan.org/factsheet/en/pdf/02RegionsofJap.pdf>)

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Tokyo loses power in huge cyber attack

Retaliation for Japanese 'invasion'; Washington also loses power?

Tuesday, April 29

Tokyo (1027 GMT – 1827 JST) - **The Futtsu power station, which is the major energy provider to the Keihin and Keiyo industrial zones, shut down yesterday following an "unprecedented cyber attack".**

Although yet to be confirmed, Chinese military hackers are thought to be responsible in an attack, which is similar to the Stuxnet virus used to disable Iran's nuclear programme. Damage estimates are yet unknown but government sources suggest it could be weeks before the power station is back online.

The attack is believed to be a direct retaliation for the incursion of Japanese soldiers into China.

The Futtsu power station, the second largest of its type in the world.

Trading has been suspended on all major stock markets following the attack as the world prepares for war.

A massive effort to evacuate westerners, mostly to India and Australia has been hampered by poor weather. It is understood that a full US-led diplomatic effort is underway.

Trading is suspended on global stock markets as fear of a world war triggers sharp falls.

Panic strikes Japan as people begin to evacuate the major cities. Many foreign nationals have already left but those who remain struggle to find ways to exit the country. A full diplomatic effort is launched to remove citizens from both China and Japan. Foreign governments provide a constant stream of flights to India, Singapore and Australia as fear of escalation spreads.

After a short period of relative calm, Japan launches a pre-dawn air raid against mainland China. Ship-launched cruise missiles and aircraft-launched air-to-ground missiles target the military bases and radar stations around Beijing, Shanghai, and the Hong Kong - Guangzhou region.

It is the start of a major period of offensive action by Japanese forces, which continues for nearly three months of nightly bombing. As the anti-aircraft defences around the cities are degraded, air raids are launched targeting the major industrial and commercial centres, in a concerted action of strategic bombing to reduce the economic power of China and change the strategic balance of military power and global influence in the region after the conflict. Assembly plants, factories, office buildings, ports, trucking and rail facilities are destroyed in concerted waves, night after night. Chinese air defense is fierce, and Japanese aircraft losses are heavy.

Despite the night timing of the attacks, and air raid warnings, tens of thousands of workers are reported killed in the first few weeks. The death toll mounts over the coming months.

China's retaliation is swift; launching similar airstrikes against industrial and commercial sites in Japan's Sendai region, and commencing an intensive bombing campaign of Japan's power plants, liquid petroleum gas plants and shipping

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BREAKING NEWS **WAR: Japan bombs China**

Japan strikes military and industrial centres in Beijing & Shanghai

Monday, May 12

Beijing (0058 GMT – 0758 CST) - **Japanese air and naval forces launched a massive strike against Chinese military targets and key industrial centres in the early hours of Monday morning.**

Cruise missiles bombarded multiple targets across China in the early hours of Monday morning.

manufacturing cities like Songjiang.

Details are still emerging but it is thought that Beijing and Shanghai were both targeted following the crippling Cyber attack against Tokyo on April 29.

The first wave of attacks, beginning around 1am CST, targeted military installations near Beijing and Shanghai. Local witnesses say the second wave of attacks began around 3am, which targeted some of China's most prolific industrial centres. There are early reports of devastating losses to massive

Chinese government officials condemned the attack and have promised "a swift response to Japan's barbarism". Western governments have joined the condemnation but have urged for calm and diplomacy as the world stands on the brink of all out war.

terminals. Japan's already restricted energy supply is further damaged, and China's strategy is now to cripple Japan's economic infrastructure and to put pressure on the Japanese government to back down. It launches waves of missile attacks against industrial sites in the Tokyo-Yokohama region. As well as suffering tens of thousands of casualties, Japan's industrial capacity suffers severe damage.

Phase 5: stalemate

The hostilities between Japan and China provokes global condemnation and the international community suffers economically from the fallout of the war, but for some period of time nobody can prevent the conflict from continuing. China's membership of the UN Security Council is suspended. The Security Council calls for an immediate ceasefire and demilitarisation of the area, but is unable to get agreement to mandate trading sanctions against the belligerent nations. Shipping of oil and gas supplies to both Japan and China are severely curtailed and energy reserves in both countries are reported running low, but critically so in Japan.

The United States declares that it is not prepared to let the Japanese population run out of fuel, and will provide Japan with the oil and gas supplies it needs. Japan agrees to suspend military attacks against China. A US shipping convoy of oil tankers heads for Japan, and the US demands that China

withdraws its naval blockade around Japan to let it pass. Aircraft carriers and supporting ships from the US Pacific fleet move into tactical positions around the South China Sea. The implication is clear. The United States is not prepared to allow Japan to lose the conflict and is now preparing to intervene militarily if necessary.

Russia protests against the US action and hints that it will make its oil and gas available to China in reciprocation, but after diplomatic pressure Russia finally aligns with the international consensus to end the conflict.

The rest of the 'democratic security diamond'- i.e. Australia and India, as well as the UK, France, Germany, and regional actors, Vietnam and the Philippines – shows public solidarity around the initiative to end the war.



For weeks the US navy and Chinese navy face off at sea, circling and withdrawing, but no shots are fired. There are no further attacks on the Japanese mainland and there is a period of stalemate between the protagonists.

Phase 6: Negotiated Peace

The United States, with Russia as a partner, calls for an immediate ceasefire, the removal of the weapons on the disputed islands, and the opportunity for both nations to address the UN on the issue of each country's Exclusive Economic Zone (EEZ).

The Chinese premier and the Japanese prime minister finally meet at peace talks in Singapore. After three days of negotiations, a peace treaty is signed, guaranteeing the free flow of trade through the South and East China Sea and gestures towards the reconstruction of each other's infrastructure. Markets respond positively.



Phase 7: Aftermath

China agrees to the conditions that any further attack would void all agreements, and that Pacific and South China Sea shipping lanes will be opened as soon as possible so that trade with the United States and Canada can begin again. Japan also agrees to the ceasefire and to the United States and Russia's role in negotiating trade relations with China, and restoring most of the US\$ 345 billion agreement.



The free flow of shipping routes returns within 3 months, causing an increase in global stock markets as some normality returned. It requires a large presence and deployment of US Naval forces, at significant cost to their economy. Commodity prices too began to drop within hours of the agreement. Ownership of the islands remain disputed, but after 9 months of conflict, 100,000 deaths, and billions of dollars in losses, neither side has the political will, fuel supplies, the public support, or the money to continue fighting.

5 Loss and Direct Impacts

Wars are destructive. In this section we consider what the consequences would be for two major military powers to strike out at each other, in terms of the direct losses that would ensue to infrastructure, people, and to the economic infrastructure.

In our China-Japan conflict scenario, phases 3 and 4 build up from a series of destructive military incidents into a full conflict phase in which the two protagonists inflict punitive damage on each other to force the other side to capitulate or negotiate.

Strategic military objectives

The consensus of unclassified war strategy studies of scenarios similar to ours suggest that the primary strategic aims of a conflict between major powers of the Pacific region would be power rebalancing.²⁶ In a conflict of this type, neither side is intent on a land war. They are not trying to colonize each other, or force regime change through invasion and conquest. Instead they are attempting to deter and punish the opposing side, degrade their military capacity, to alienate the general population from their leaders, and crucially, to inflict economic losses that will weaken the opposing side and reduce its global influence and economic power to change the strategic balance of military power in the region after the conflict.

Evolution of military strategy

Military strategic thinking has evolved over the past century.

Strategic bombing in World War II was intended to destroy the enemy's ability to wage war, and was a long term attritional strategy to degrade the opponent's war machine in preparation for the eventual invasion of land forces to decapitate leadership and obtain surrender. Primary targets included government military infrastructure, weaponry, communications, detection systems, and secondary targets were munitions manufacturing, transportation, and the civilian population. Civilian targeting was seen as a necessary component, to demoralize the enemy population and alienate it from its leadership. Strategic bombing in WWII was carried out by aircraft raids, dropping bombs with low accuracy but in large volume.

²⁶ See for example strategic studies and conflict scenarios that feature in Yoshihara (2010); Kaplan (2011); Thayer (2013); Smith (2013); Kleine-Ahlbrandt (2013); International Crisis Group (2012).

'Shock and Awe' in 2003

The military campaigns of the 2000s changed strategic thinking. Aided by new levels of targeting precision with smart missiles, the US 2003 strategy for the Gulf War aimed for a 'Shock-and-Awe' bombing campaign in Iraq. A high intensity of precision-bombing of military targets was carried out, but with a specific objective of achieving low civilian casualties – using state-of-the-art guided missile technology and avoidance of strikes with potential for collateral deaths. This was considered largely unsuccessful, as it did not achieve 'a surrender mind-set' in Iraq commanders, and did not achieve its objective of greatly shortening the ground war²⁷.

Strategic Bombing Precedent Case Study Baghdad 'Shock & Awe' 2003



Iraq War

19 Mar 2003 – 30 April 2003

- 1,700 air sorties
- 504 Cruise missiles
- 6,616 civilian deaths
- Complete destruction of military and government infrastructure
- Bombing and land invasion ultimately responsible for 0.5% mortality in Iraq population
- Population of Baghdad in 2003: 4.8 million
- Mortality Rate: 1.4 deaths per 1,000 population

21st century strategy

Military thinking since then has deprioritized the objective of demoralization through strategic bombing. The efforts made to spare civilian

²⁷ Strachan (2013); Johnson & Tierney (2006).

casualties are thought to be counter-productive, but also the targeting and strategic focus has shifted. Against a powerful adversary, a military campaign is not expected to force a capitulation. Instead, relatively short campaigns are envisioned, where the adversary is significantly weakened as a future world power through the destruction of their economic infrastructure.

21st Century military theory stresses the destruction of an enemy's economic means of production as a key method of debilitating and reducing their world power after the conflict period. The likely objective of a future campaign against a strong adversary is to reduce an enemy's future economic power.

China-Japan scenario strategy

In a future scenario where China and Japan strike militarily at each other, we could expect to see the primary strategy being power rebalancing through the destruction of each other's economic capacity.

Strategic Bombing Precedent Case Study Bombing of Dresden, Germany, WWII



World War II

13–15 February 1945

- 527 US & 722 UK bombers drop 4,000 tons of ordnance
- 15 sq. miles destroyed, inc. 90% of city centre
- Around 25,000 dead, several hundred thousand injured.
- 23% of industrial buildings 'seriously damaged'
- 78,000 dwellings 'completely destroyed'; 28,000 'uninhabitable'; 65,000 damaged
- 199 factories (136 serious damage; 28 medium damage; 35 light damage)
- Population of Dresden in 1945: 650,000 to 850,000 people
- Mortality rate: 33 deaths per 1,000 population

In our scenario, the first wave of attacks is guided missiles on military targets, particularly air defense systems, naval front-line ships, early-warning, and detection systems. These attacks are fairly precise but some collateral damage is caused to civilian facilities in the vicinity. Naval bases are attacked, ships at sea, and radar and anti-aircraft defence systems. This is to restrict counter-defense to enable aircraft bombers to enter enemy air space without suffering unacceptably heavy losses.

The second wave of attack is aircraft raids targeted on major economic facilities, including manufacturing plants, port facilities for export shipping, and goods transportation hubs. Bombing is largely at night, in a gesture to minimize casualties in the workforce. Both countries target each other's energy facilities, but China specifically goes after Japan's power stations and energy distribution systems, as a known economic vulnerability after the Fukushima nuclear failure in 2011.

Cyber war

A new element of warfare is introduced with cyber-attacks on the computer systems controlling Japan's energy infrastructure. This results in major failures of power plant production and distribution grids.

United States warnings to China to cease hostilities or face US military intervention are ignored, and a unexplained power grid failure in Washington D.C. is widely interpreted as a Chinese cyber-attack to demonstrate retaliatory capability.

Estimating damage

To estimate the type and severity of damage that we might expect to see as a result of these hypothesized attacks we undertook an exercise of mapping likely major military and commercial targets in selected cities. We combined this with a review of historical examples of strategic bombing consequences, to consider levels of past destruction precedents. (See inset boxes for examples).

Strategic Bombing Precedent Case Study
The Blitz – London 1940



World War II

7 Sept. 1940 – 21 May 1941

- 40,000 dead
- 100,000+ injured
- 1 million homes destroyed
- London bombed for 57 consecutive nights
- 25% drop in industrial production
- Population of Central London in 1940: 4 million
- Mortality Rate: 10 deaths per 1,000 population

Combat Zone cities

We assumed that attacks on China were mainly focused on the main cities of Beijing, Shanghai, and the Hong Kong-Guangzhou conurbation. In Japan, attacks were focused on the Greater Tokyo area, including Tokyo, Yokohama and Kawasaki. These were designated as the primary Combat Zones, as mapped in Figure 5.

Targets within Combat Zones

Within Combat Zones, we mapped potential military and commercial facilities that would be natural targets in a strategy of ‘economic power rebalancing’ to assess potential loss ratios for the commercial facilities in general within a Combat Zone. Targets included the export processing zones, the manufacturing centres and clusters of central business activities, as well as power and goods transportation facilities. We assumed strike patterns of concentrated attacks on business areas of a few kilometres radius within the large area of the city containing clusters of commercial facilities, consistent with historical precedents of strategic bombing. There is no targeting of civilians or attacks on residential areas.

Property losses

Analysis suggests that within a Combat Zone in the initial S1 scenario, over 1.2m commercial

properties are damaged during the bombing, 800,000 in China, 400,000 in Japan. This is approximately one in a thousand of the commercial properties that are located in the Combat Zone areas, typically the larger and higher profile facilities. Average loss ratios on a damaged property would be around 50%. Ports and major infrastructure are also badly damaged.

Strategic Bombing Precedent Case Study
Fire Bombing of Tokyo 1945



World War II

17 Nov 1944 – 15 Aug 1945

- Incendiary bombs target light industry
- 9-10 Mar, 334 bombers drop 1,700 tons of ordnance
- 16 sq. miles destroyed (280,000+ homes destroyed) 50% of Tokyo
- 100,000 dead, over 100,000 injured, and 1 million homeless
- Industrial output cut by 50%
- Rebuilding focused on roads / transportation
- 27% of the damage but only 11% of rebuilding budget
- 5-7 yrs before economic growth returned
- Population of Tokyo 1945: 3.5 million
- Mortality Rate: 28 deaths per 1,000 population

Using estimated property and construction values, this suggests a replacement cost valuation of over \$120 billion. Using more conservative values for replacement cost, higher intensity of destruction, and a longer duration of conflict suggests replacement cost values of over \$500 billion (X1 variant). To put this in context, the most costly natural disaster in history was the Tohoku earthquake in Japan in 2011 with an estimated damage cost of \$235 Billion²⁸. The most costly natural disaster in China was the Sichuan

²⁸ World Bank (2011).

earthquake of 2008 with a damage cost of \$29 Billion²⁹. These natural catastrophes devastated entire regions, leaving hundreds of thousands homeless, whereas the envisioned destruction in this conflict scenario is in small, localized geographical areas, but highly targeted on key, high value facilities.

Casualty estimation

Casualty estimation is more difficult. We have chosen to use reference casualty numbers from strategic bombing precedents, adjusting for population density and targeting sensitivity. We have assumed that civilians are not deliberately targeted but also that there is no policy of avoiding targets to prevent casualties. Some studies of conflicts have concluded that mortality statistics are misleading and that long-term effects of conflicts include economic hardships, increased disease and premature death, and other less easily quantified.

The total population of the Conflict Zones is 44 million. Applying mortality rates from the historical precedents of strategic bombing of large cities (1.4 deaths per 1,000 population in Baghdad in 2003 to 33 per 1,000 in Dresden in 1945) would give a casualty estimate in the conflict zones ranging from 60,000 to 1.4 million dead. We have opted for the lower end of this spectrum, applying a mortality rate a little higher than that of Baghdad 2003 (2.3 per 1,000) for scenario S1 to estimate 100,000 deaths, to around that of the London 1940 Blitz (11 per 1,000) for X1, which gives a death toll of 500,000.

From the distribution of assumed strike areas and targeting patterns, we estimate that the 75% of these casualties will be in China, and 25% in Japan.

Injury statistics from historical bombing campaigns are not well recorded, but serious injuries, like severe trauma, needing hospital treatment appear to be one to five times the number of deaths. Minor injuries (contusions and minor trauma) can be three to seven times the number of deaths. Table 5 shows an estimated distribution of injury severities that might be expected in the civilian population caught up in the scenario (S1) based on injury distributions blended from combat epidemiology³⁰, bomb victims³¹, urban building collapse disasters³², and

other data. This provides a guide for the relative severities of injuries that might be expected, graded according to treatment and compensation categories. Injury classes I2 to I6 require hospitalization.

	Injury Classification	Total Casualties	Ratio to deaths
I1	Minor injury	450,000	4.50
I2	Temporary Incapacity	80,000	0.80
I3	Partial Disability Minor	65,000	0.65
I4	Partial Disability Major	45,000	0.45
I5	Complete Disability	40,000	0.40
I6	Deaths	100,000	1.00
		780,000	

Table 5: Injury severity distribution for casualties in conflict scenario (S1 variant)

Insurance losses

Exclusion clauses in property insurance policies for 'Acts of War' prevent claims for damage to buildings, cars, commercial facilities and industrial structures. We assume that these exclusion clauses hold and there are no losses to insurers from property damage³³.

Insurance companies may take this to mean that they would suffer no losses as a result of a geopolitical conflict.

In this section we explore where losses might arise in an insurance company's underwriting portfolio, to apply this China-Japan conflict scenario as an insurance company stress test. We are particularly interested in exploring where losses could occur that might be a surprise to an insurer, and identifying what assumptions would be included in an underwriting loss stress test.

There are many lines of insurance written across the industry, so this exercise explores what kinds of losses might arise from each line. This is necessarily qualitative. We do not know the insurance industry exposures across the various lines in the markets that would be affected in this scenario, or the specific terms and conditions of policy coverage, deductibles and limits that might apply. Instead we discuss the types and scales of potential loss, for individual companies to consider their own exposure.

The primary objective is to consider the correlation of loss that might occur across many different lines of business that under normal conditions are broadly independent. It is only in an extreme

²⁹ World Bank (2008).

³⁰ Epidemiology of military injuries in combat shows a strong bimodal distribution, for example in Bellamy et al. (1986).

³¹ Terrorist bombing attack data (Beirut barracks 1983, London bombing 2007; Oklahoma City bombing 1995; Boston Marathon bombing 2012)

³² Earthquake victim injury distribution data compiled in Coburn & Spence (2002).

³³ In scenario variant X1 we assume that the Act of War exclusion clause does not hold.

scenario that correlation of this type occurs, with simultaneous losses being triggered in multiple lines. Later in this report we also consider how underwriting loss might correlate with a simultaneous shock to the investment portfolio of an insurer, as an input to considering capital requirements for the combined effects of market and underwriting risk.

- **Commercial property** Although there is heavy damage to major manufacturing facilities, industrial plants, and commercial office buildings, and extensive business interruption to the companies operating in them, these are claims for which insurers would not be liable under Act of War exclusions. If these exclusions were not to hold, then property insurance losses could be significant.

- **Residential property and personal lines** Similarly, Act of War exclusions should prevent claims under residential buildings and contents insurance, and private auto insurance. Damage is not expected to be heavy in residential areas, but some damage should be expected.

- **Group and individual life insurance** Life insurance does not typically have act of war exclusions. Payouts can be expected on group life and individual life insurance policyholders who are killed in the scenario. Japan is one of the largest life insurance markets in the world, estimated to have over 200,000 life policies – 1.6 policies per person in the population. China has much lower life insurance penetration – having an estimated ratio of one life policy per 20 persons on average. These ratios and policy values per life are likely to be higher in the key cities affected. In estimating their possible life insurance exposures, insurers should include expatriate managers temporarily located in the regional office impacted by the event, but covered by group life policies taken in other countries where they are based.

- **Personal accident and health** Employees in the damaged workplaces are likely to have group benefits including accidental death and healthcare insurance. Hospital and physician treatment costs and compensation payouts for injuries can be assessed from the injury severity distributions. Disability compensations can be extensive and long term. It has not been part of this study to assess compensation amounts for injuries, but these can greatly exceed death benefits, per person.

- **Workers compensation** Japan has workers' accident compensation insurance as part of their labour insurance package. Employees based in US, Australia and other countries that also operate workers compensation and who are

working in China or Japan and are injured in the course of pursuing their work will be entitled to compensation. Injuries to any of these workers will trigger compensation payouts.

- **Repatriation costs** There is a large exodus of expatriate workers from their regional offices in China and Japan, and possibly other countries in the region. Some of these costs may be claims on group benefit packages for corporate covers.

- **Marine** Insurers wanting to use this scenario as a stress test may include a major shipping loss as part of their total claims. In this scenario we describe a major shipping accident (loss of an Ultra Large Container Vessel with 15,000 containers) in the early phases of the posturing between the belligerents. Accident investigators find insufficient evidence to attribute the loss to an act of war, and policy war exclusions are challenged by the insureds.

In scenario variant S2 we assume that many of the commercial vessels in ports in the Conflict Zones are damaged by the air attacks. Insurers need to ensure that their marine war exclusion terms are robust to avoid major losses from this.

- **Aviation** Insurers wanting to use this scenario as a stress test may include an aviation loss as part of their total claims. In this scenario we describe a major aircraft loss during the period of high tension. Accident investigators find insufficient evidence to attribute the crash to an act of war, so policy war exclusions are challenged by the insureds.

In scenario variant S2 we include commercial airports in the attack targets. A large proportion of the aircraft on the ground at Narita airport in Tokyo and Pudong airport in Shanghai are damaged as a result of attacks. Insurers need to ensure that their aviation war exclusion terms are robust to avoid major losses from this.

- **Energy** Onshore and downstream energy facilities are badly damaged in the conflict scenario. War exclusion terms have to be robust to avoid major insurance losses from this.

- **Space** Established Japanese commercial satellites are lost, suspected due to military action, but unable to be verified.

- **Contingent business interruption** The conflict scenario prevents the fulfillment of suppliers based in southeast Asia providing products and services to the rest of the world. Businesses that suffering losses and that have CBI cover for this, make claims.

- **General and specific liability lines** There are a number of Casualty lines that could be impacted by the scenario. These include

Employer's liability, management and professional indemnity insurance, Directors and Officers liability, Errors and Omissions policies and others. For each of these, understanding what claims might arise is a process of tracing the five steps of 'duty of care': establishing that there is a duty, that there is a failure, that the failure is foreseeable, that harm resulted, and that there was causation.

The most severe liability settlements are likely to be those arising from deaths and injuries to employees from any management decisions or failure to act to prevent the harm occurrence.

More complex areas are liability suits that might arise from commercial losses. The primary harm in this scenario for most companies is loss of trade. Major losses from business failures arising as a result of supply chains being disrupted and counterparties breaching service agreements tend to trigger sizeable legal actions and liability claims. Companies that suffer sizeable stock devaluation similarly find themselves defending actions from stockholders.

Attitudes are changing, and legal judgements are always interpreting what might be interpreted as 'foreseeable'. It is plausible that liability actions could be settled in favour of plaintiffs alleging that the conflict was foreseeable.

It would be reasonable to expect a significant level of liability insurance claims from the widespread economic damage that ensues.

- **Environmental liability** Spillage from the refineries and energy facilities that are attacked are likely to cause an environmental disaster for the immediate surrounding areas. Companies that might be perceived to have made insufficient effort or adequate contingency plans to protect against such an occurrence may be the subject of legal actions.
- **Travel insurance** The scenario covers a very large population and would impact large numbers of travellers, so even insurance lines like travel insurance will see a large incidence of claims.
- **Trade credit insurance and counterparty liabilities** The consequences of the scenario ripple all around the world, causing a global recession and economic hardship in many countries. Companies will default and fail as a result of the business problems that arise from this, and this will trigger failures in counterparties and losses in trading relationships. This will cause significant losses in trade credit insurance and in counterparty contractual liabilities.

Unexpected insurance claims

Insurers can reasonably expect that most of the losses that occur in the conflict scenario will be the responsibility of the national governments, and that war reparations will be made to repair and compensate the individuals and companies who suffer losses. Insurers are not responsible for losses arising from a war and could not run their businesses if they were liable for losses from wars. However, this scenario tests the assumption that insurers would see minimal claims from a conflict situation.

Claims could potentially arise from a wide variety of sources, some of which are identified in the discussion above, and a summary chart of lines of business that might see increased losses is presented in Table 6.

For example, insurers might not expect to receive claims from corporate policyholders in United States as a result of a conflict ten thousand kilometres away. However in this scenario claims arise on US exposure from power outages in the Washington D.C. region – possibly the consequence of an unverifiable cyber attack on the power grid. Insurance losses arising from companies suffering commercial harm from cyber attacks is explored in the companion Centre for Risk Studies report on a cyber catastrophe scenarios³⁴.

The potential for large losses is also increased as a consequence of compounded or follow-on catastrophes. We try to explore what consequences of the scenario could lead to increased exposure to perils that insurers may be conventionally liable for. What if the conflict in the China Sea resulted in a major concentration of ships anchored outside the sea exclusion zone waiting for conflict cessation, and a major typhoon were to occur? What if opinion shifted to believe that in retrospect this conflict was eminently foreseeable, and that companies and their management are responsible for the majority of their own losses so that insurers are hit with a wave of liability claims that might not be predictable from legal precedent?

The most difficult to foresee and plan for is political pressure on insurers to pay for losses not included in their coverage or charged for in their premium collection. There is a long history of political interference and market pressure on insurance companies to settle generously to generate goodwill and future continued insurance purchasing. Examples include settling claims of fire-following-earthquake in the San Francisco

³⁴ Centre for Risk Studies, 2014, *Stress Test Scenario: Sybil Logic Bomb Cyber Catastrophe*, Ruffle et al. (2014).

Class	Line of Business	
Property		
	Personal Lines/Homeowner	4
	Personal Contents	4
	Commercial Combined	5
	Construction & Engineering	3
	Commercial Facultative	5
	Binding Authorities	3
Casualty		
	Workers Compensation	5
	Directors & Officers	4
	Financial Lines	4
	General Liability	4
	Healthcare Liability	5
	Professional Lines	4
	Professional Liability	3
Auto		
	Personal Lines	4
	Commercial & Fleet	5
Marine & Specie		
	Cargo	5
	Marine Hull	5
	Marine Liability	3
	Specie	4
Aerospace		
	Airline	5
	Airport	4
	Aviation Products	3
	General Aviation	2
	Space	4
Energy		
	Downstream	1
	Energy Liability	4
	Onshore Energy & Power	5
	Upstream	3
Specialty		
	Accident & Health	5
	Aquaculture Insurance	1
	Contingency – Film & Event	1
	Equine Insurance	1
	Excess & Surplus	0
	Life Insurance	4
	Livestock	3

Class	Line of Business	
Life & Health		
	Life Insurance	5
	Health Insurance	5
	Income Protection	0
	Death & Disability	5
	Hospital Cover	5
Pension and Annuities		
	Standard Annuities	0
	Variable Annuities	0
	Enhanced Annuities	0
	Life Settlements	0
War & Political Risk		
	Kidnap & Ransom	0
	Political Risk	5
	Political Violence & Terrorism	0
	Product Recall	0
	Trade Credit	3
Agriculture		
	Multi-peril Crop	3
	Crop Hail	0
	Livestock	4
	Forestry	0
	Agriculture	0

Impact on Insurance Claims



Table 6: Impact of conflict scenario on claims pattern for different lines of insurance

earthquake of 1906, flood-following-hurricane losses after Hurricane Katrina in 2005, loss settlements after Superstorm Sandy in New York in 2012. Political dimensions shape insurer payouts from events such as the 2010 Deepwater Horizon oil spill compensation. In scenario variant X1, we postulate that international insurance companies come under pressure from the Chinese government to pay a much greater share of the damage to commercial facilities than their legal minimum obligations. The Chinese authorities let it be known that the cost of continuing to operate insurance business in China in the future is generous settlement of claims with Act of War exclusion clauses. As part of a stress test, insurers may want to consider the costs and benefits of how this scenario would play out across the market.



Corporate operational risk example

Pomegranate Inc., is a fictional company used to illustrate the possible effects of scenarios on a corporation. Pomegranate is assumed to be a US consumer electronics company, the 9th largest international player in the highly competitive computer hardware market. It has 100,000 employees worldwide, with headquarters in California, U.S.A., and operates in 75 countries, deriving three quarters of its sales from the main markets of US, Japan, China, and Europe. It sells computers and associated products which it assembles in China, from components and manufacturing suppliers in 20 different countries. It produces over 10 million laptops & tablet units a year. Its new flagship product range is the *Pomegranate Persephone 5G* tablet computer, currently being launched into a highly competitive consumer market and fighting for market share.

In the conflict scenario Pomegranate suffers badly:

- Staff in Pomegranate offices and manufacturing facilities are injured and killed during the bombing raids on Conflict Zone cities in China. Management of Pomegranate are heavily criticized for not ceasing commercial operations and evacuating all personnel when the conflict was looming. Liability law suits are brought against the company for failing to protect employees.
- The primary assembly plant for Pomegranate products, located in Shanghai Export Processing Zone, is destroyed in the air strikes. Suppliers of components are heavily concentrated in the conflict region and are unable to ship components.
- Production of products ceases and Pomegranate realizes it has to find alternative manufacturing capacity elsewhere. Many other companies are also engaged in a similar hunt, and Pomegranate's slow start means that competitors have snapped up available spare capacity worldwide. They establish new facilities in Brazil, but it takes nine months to get assembly capacity up and running.
- The Pomegranate launch of its new flagship product, the *Persephone* tablet computer, suffers from lack of available units to sell. Pomegranate loses market share to competitors in its vital opening season.
- Pomegranate sees a 40% stock price fall.
- Stockholders bring a class action against the company executives for failing to have adequate contingency plans for a crisis of this type. The company notifies its insurer of an action under its Directors and Officers liability insurance policy.
- Pomegranate corporate bonds are downgraded by rating agency, making them no longer investment grade.

6 Macroeconomic Analysis

Economic impact of wars

Wars are expensive in capital, resources and labour, disruptive to trade, limit access to resources and interfere with business management. The overriding effect of war is to destroy valuable capital (human and physical) and to depress long-term economic output. Losing major wars in the twentieth century precipitated the break-up of the Austro-Hungarian Empire and proved catastrophic for the German and Japanese economies. Even in victory economic costs can be devastating. The First World War cost the British economy approximately 65% of Gross Domestic Product (GDP). There are economic boosts too – rearmament and wars have lifted economies out of depression. The development of the US military industrial complex following the attack on Pearl Harbor in 1941 began to restore the losses suffered during the Great Depression.

Economic impacts Great War 1914–1918

The First World War impacted the economies of the major belligerents in different ways. While the British economy received a demand boost, the French, German and Austro-Hungarian economies shrank during the hostilities, see Figure 7.

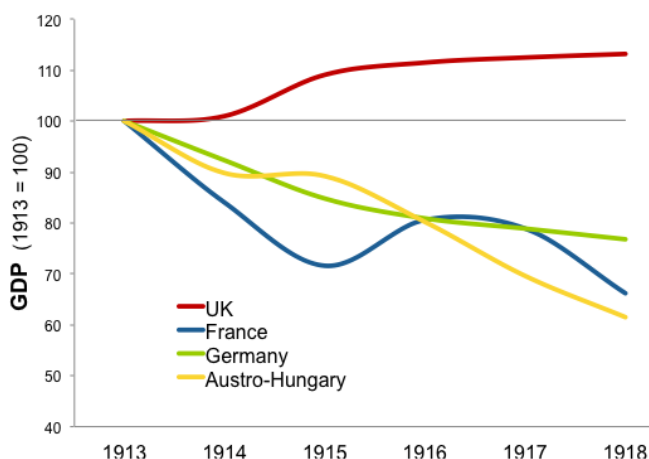


Figure 7: GDP of major belligerents during World War One (1913=100)

More agrarian economies found it harder to shift resources into munitions while maintaining production of food and consumption goods at pre-war levels. France, for example, suffered the added disadvantage of having a region that had produced 80% of its steel, 55% of its coal, and 43% of its electricity under enemy occupation. In contrast, the relatively advanced British economy was able to increase industrial production without adversely affecting aggregate output. Hostilities naturally disrupted the pattern of trade.

Britain and Germany were major trading partners before the First World War, and the freezing of overseas assets in 1914 produced a global financial crisis. With ships diverted to wartime use, and a successful British naval blockade, German exports fell to just 28% of their pre-war level by 1918, with imports falling to 39%. Britain fared slightly better, with exports falling to 47% of the pre-war level. Increased imports of food and war materiel meant British imports never dropped below 90% of the 1913 level. However, the loss of overseas markets during the war, and the decision to return to the gold standard at the pre-war parity contributed to a miserable four decades for British exporters, who did not regain their 1913 volumes until 1954.

Britain did, however, benefit from their taxation system, raising taxes to 16% of GDP by 1918, while the German and French governments could only bring in a maximum of 11% and 10% respectively, thus requiring increased government borrowing. Although most wars are debt-financed, the type of debt is critical: Britain's debt/GDP level (118%) surpassed Germany's (109%) at the armistice, but the more advanced British financial system was able to absorb more long-term debt, and avoid the hyperinflation Germany experienced in the 1920s.

Economic impacts of World War Two

The Second World War had an immediately positive impact on the GDPs of the UK, US, Germany and Japan, reflecting the more advanced level of industrialisation vis-à-vis 1914 (see Figure 8). In addition, the Axis powers had been rearming for several years, so the transition to a wartime economy was less of a 'shock'.

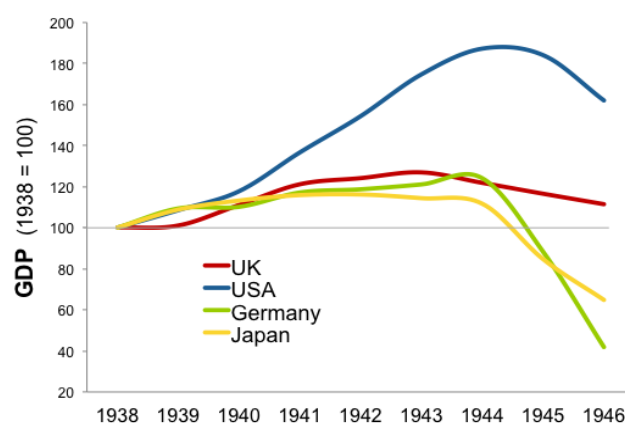


Figure 8: GDP of major belligerents during World War Two (1938=100)

The USA received a significant demand boost from the war, but German and Japanese economies suffered collapse, not regaining their peak wartime

levels of output until the mid-1950s. US government expenditure as a share of GDP peaked at 44% in 1944, versus 89% in Japan and 87% in Germany. Further, the US government was able to extract 21% of GDP in taxation in 1944, versus just 14% in Japan in 1943. As a consequence, US debt/GDP peaked at 122% in 1946 versus 204% in Japan in 1944, where prices rose by 975% a year later. The British government was once again able to extract the largest share of taxation from its economy, with 33% of GDP accruing to the Treasury in 1945. As with the other belligerents, Britain financed World War Two primarily with debt. Britain entered the war with a debt/GDP ratio of 138%, (versus 32% in Germany, 44% in the USA and 70% in Japan). In 1946 British debt/GDP stood at 237%. Inflation was contained to below 8% after the war (having reached 13.7% in 1940) as the government continued to ration food and consumer goods into the 1950s.

The outcome of the two world wars shows that size becomes increasingly important as war progresses. The Axis powers used mobility, speed and surprise to inflict early defeats on economically powerful opponents during World War Two. However, even at the height of their success, the major Axis powers could call on only half the economic resources of their opponents. The British and American economies were able to transfer resources from consumption to the war effort without reducing their populations to subsistence living. This helped to avoid the widespread hostility to war that saw the Russian regime overthrown in 1917 and the country exit the First World War. A well-developed financial sector and a broad tax base are also important, both for financing the war and minimising the economic dislocations of the peace.

Macroeconomic effects of war

Governments pay for war using four primary mechanisms.

Exhaust reserves, which can increase susceptibility to shocks and affect interest rates; use any surplus, which increase inflation, and sell its assets for cash.

Borrow money by selling bonds and raising government debt. War related debts, however, can drive states into bankruptcy and leave governments with costly long term loan repayments.

Taxation increases, which diverts spending in the real local economy into the areas where the war is being fought. Increasing taxes also has the undesired effect of suppressing enterprise and investment.

Print more currency, which fuels inflation and acts as an indirect tax on the national economy that financed the war.

Increasing government expenditure will have positive short-term effects (e.g. increased employment and demand) but is also likely to cause long-term negative effects. Negative effects have an impact when loans and interest rates are eventually repaid through increases in tax and diversion of investment in public expenditure. Prices also increase due to inflationary pressures and the benefits of local investment and innovation through enterprise are negated through higher taxes.

Increased inflation

A common historical fact of almost every war is an increase in consumer prices which lowers living standards. The Chinese war strategist Sun Tzu (c.400 BCE) found a direct correlation between the presence of an army and high prices, exhausting the wealth of people wherever an army was present. Demand-pull inflation occurs when there is a surplus of expenditure creating excess demand and raising prices. In war this will most likely occur because of increased government expenditure. Cost-push inflation occurs when there is a shortage of supply thus causing prices to increase. Import inflation occurs when imports are delayed, blocked or diverted causing an increase in prices. In war, all three types of inflationary pressure are important drivers of monetary devaluation.

Reduction in foreign direct investment

Inward Foreign Direct Investment (FDI) is investment in production activities and businesses in a target country by a corporation or individual from another country. Businesses that operate in countries at war experience higher levels business risk. Upstream supply chains face disruption of raw materials and resources and other intermediate goods required for production. Down-stream supply chains are also disrupted affecting customer relations, limiting market penetration and preventing final products making it to market. The effect of these constrains results in reduction of inward FDI flows from other countries into the country at war.

Capital flight

Capital flight is when assets or money is taken out of its country of origin. Capital flight occurs when investment or business activity is either too risky or too expensive to continue within the country in question. During war, capital flight will occur because businesses will want to protect

investments, either from the direct consequences of war or from risk of decreasing returns.

Capital destruction

War zones typically create intense destruction of productive capital such as farms, factories and cities. Reducing the overall level of the capital stock has a significant effect on productivity. For example, as a direct consequence of the bombing in World War One, France suffered nearly a 50% reduction in productivity.

Economy of China

Economic background

In 2013, the Chinese economy grew by 7.7% with an annual output of US\$9.26 trillion. Gross Domestic Product for 2014 is predicted to reach US\$ 10.43 trillion. The US and the EU are the only other two regions in the world with total economic output over US\$ 10 trillion. In 2007 China overtook Germany to become the third largest economy in the world and by 2011 it had overtaken Japan as the second largest. China appears to be on track to surpass the US as the largest economy sometime in the 2020s. China is the fastest growing major economy with an average growth rate of 10% per annum over the last 20 years. During the most recent Global Financial Crisis, China was one of only a few countries that managed to escape dipping into recession.

In 1980, the Chinese economy accounted for just 1.9% of global economic output; in 2013, that contribution had risen to 15.5%. China's emergence as a major global economic force is largely attributed to the economic reforms of the late 1970s. These policies included the decentralization of control and the creation of 'special economic zones' to attract foreign direct investment. Considerable industrial growth followed, particularly in the production of consumer goods destined for international markets. While China's growth and strength in absolute economic terms is widespread, it is still a relatively poor country; with 1.38 billion people, its per capita income is just US\$ 9,700, compared to the United States with US\$ 46,000.

China is still considered to be a socialist market economy with a Government that likes to have close control over the economy, particularly on foreign policy involving capital markets and in setting exchange rates. In addition, state owned enterprises continue to dominate many key economic industries in China.

Most development and investment in China is concentrated on the Eastern seaboard, creating huge disparities between the urban rich and rural

poor. Most of China's large cities are also the country's main shipping ports (e.g. Shanghai, Tianjin, Guangzhou). As the largest manufacturing economy in the world, it is unsurprising that China is also the world's largest exporter, accounting for 9% of global trade; it is also the second largest importer of goods only behind the US.

A cornerstone of China's economic policy is managing its currency to benefit exports. China does not have a floating exchange rate determined by market forces; instead it pegs the Yuan to the US dollar. In July 2005 the currency was allowed to appreciate by 2.1% against the US dollar and moved to a managed float system where it was allowed to appreciate against a basket of currencies. However, it is believed that the Yuan is still significantly undervalued; if it were allowed to float properly, the Yuan would appreciate significantly. To cap this appreciation, China buys dollars and sells Yuan, resulting in a significant increase in China's foreign reserves. In the final quarter of 2013, reserves stood at US\$ 3.68 trillion, 80 times the amount of US-owned foreign reserves.

Modelling implications

China represents somewhat of a special case from a macroeconomic modelling standpoint.

The industrial powerhouse of the Chinese economy is concentrated on the Eastern seaboard making it particularly vulnerable to attack from the sea. Moreover, the Chinese economy is heavily dependent on overseas exports, which face severe disruptions in the event of war. This also has significant implications for China's major trading partners.

Although Chinese markets have been pseudo-liberalised over the last several decades the government retains significant control over the economy giving it the power to manipulate exchange rates and implement capital controls quickly.

Given the Chinese government's stance on capital controls that restrict Chinese citizens and businesses from investing in foreign assets, it is likely that even tighter capital controls will be implemented in the event of a war to mitigate the effects of capital flight. It is therefore likely that, to prevent disinvestment, China will implement a fixed exchange rate.

The significant size of foreign reserves owned by China, primarily through the purchase of US government bonds of which it owns 27%, suggests that China will be strategic in the event of war. China will likely not risk US treasury bonds being seized and will likely stop short of any all-out military confrontation with the USA.

Economy of Japan

Japan is the third largest economy in the world after the USA and China and has a per capita income of US\$ 37,395. It is the largest manufacturer of electronics and the third largest manufacturer of automobiles in the world. In 2013, the Japanese economy grew by 0.3% with an annual output of US\$ 5.94 trillion. Following World War Two, Japan's defence spending was cut and economic growth was prioritised. Throughout the 1960s average growth rates were around 10%, 5% in the 1970s and 4% in the 1980s. This period of strong sustained growth established Japan as the world's second largest economy between 1978 and 2010.

Japan has a dearth of natural resources to support its population and growing economy. The majority of exports from Japan are derived from Japan's comparative advantage in high tech engineering oriented industries such as robotics, optical instruments and hybrid vehicles. Japan built up its expertise in manufacturing and processing industries to convert resources from abroad into high value products that could be re-exported to other advanced economies. This strategy required significant investment in energy, transport and telecommunications infrastructure. Exports are the lifeblood of Japan, accounting for almost 5% of global exports; imports account for 4.5% behind only the US, China and Germany.

In the second half of the 1980s a stock market bubble and the rising cost of real estate caused the Japanese economy to overheat and eventually crash. During the 1990s, the Japanese economy grew at only 1.5%, well below most other developed countries. Insufficient economic growth, declining tax receipts and an aging population supported through welfare payments has saddled Japan with substantial public debt. As a percentage of GDP Japan has the highest public debt in the world, recently surpassing US\$ 1 trillion.

What the Japanese government lacks in public finances is more than made up in foreign reserves held by the private sector. In 2013 Japan possessed over 12% of the world's private financial assets estimated at over US\$ 12 trillion, second only to China's US\$ 36 trillion. Persistent deflation, a reliance on exports to drive growth and an aging shrinking working age population are the major long-term challenges for the Japanese economy.

Modelling implications

Japan's stagnated and slow growing economy and large public debt make it an interesting case study in this war scenario.

Japan has significant industrial capacity and has a comparative advantage in the manufacture of highly sophisticated technologies. As an island nation it is open to attack from sea and air leaving its core industries and large infrastructure systems such as energy and transport at risk.

The Japanese economy is highly reliant on imports that are used as a factor of production in many of industries. A disruption to shipping would be detrimental to the Japanese economy.

The Japanese economy is highly integrated into the global financial system. Exchange rates are floated on the international markets and capital moves in and out of the country freely.

Inward Foreign Direct Investment (FDI) in Japan is very low and in absolute terms represents only 1% of the absolute value Foreign Direct Investment coming into China.

In 2011, the Tohoku earthquake and tsunami sent Japan into recession. Several years on from the disaster the Japanese economy is still fragile and would easily slip back into recession.

Macroeconomic model types

Macroeconomists take an eclectic approach to modelling. The most widely used macroeconomic models are commonly described as computable general equilibrium models (CGE).

Macroeconomic models are useful in bringing order and structure to complex phenomena, and to explore the 'what-ifs' of economic consequences. However, while they provide guidance and insight, their outputs must be used appropriately and treated with caution and scepticism. Each type of economic model was developed for a specific purpose and is only as good as its assumption sets. Real economic behaviour is complex and the simplifications that result from a modelled view can only provide indications of comparative directionality.

Oxford Economics Global Economic Model

The model used in this analysis, the Oxford Economics Global Economic Model (GEM), is the most widely used international macroeconomic model with clients including the IMF and World Bank. The model provides multivariate forecasts for the most important 47 economies of the world with headline information on a further 34 economies. Forecasts are updated each month for 5-year, 10-year and 25-year projections.

The GEM is best described as an eclectic model, adopting Keynesian principles in the short run and a monetarist viewpoint in the long run. In the short run output is determined by the demand side of the economy, and in the long term, output and

employment are determined by supply side factors. The Cobb-Douglas production function links the economy's capacity (potential output) to the labour supply, capital stock and total factor productivity. Monetary policy is endogenised through the Taylor rule, where central banks change nominal interest rates in response to changes in inflation. Relative productivity and net foreign assets determine exchange rates, and trade is the weighted average of the growth in total imports of goods (excluding oil) of all remaining countries. Country competitiveness is determined from unit labour cost.

Macroeconomic modelling of the scenario

To model the effects of a China-Japan war, a number of key indicators were selected to simulate the effects of the war scenario. Shocks were chosen based on historical precedents that would be expected to occur during a Chinese-Japanese war. While the war might last for only a few months, most of the shocks applied in the model persist and generally last for a period of one year before return to baseline over the next several years. Several of the variables were shocked for a longer period to represent the ongoing macroeconomic effects created by war. The effects of war on some variables were very long lasting and have very high macroeconomic inertia in the system thus taking several years to return to pre-disaster levels. An example of this is the effect of war on global trade. Prior research has shown that trade between belligerents who have been at war takes several years to return to normalcy (see Figure 9). In general, however, most shocks were applied over a short duration and then were allowed to recover endogenously.

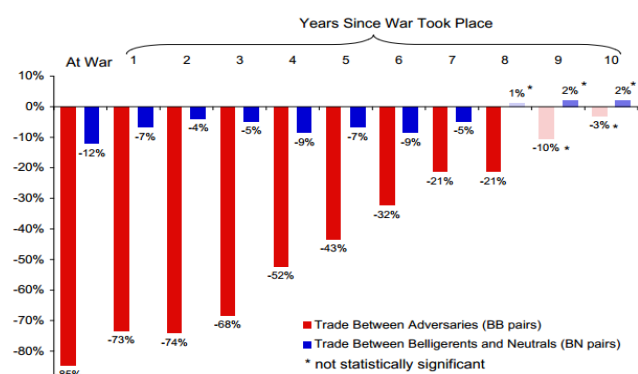


Figure 9: Duration of impact of war on trade for a given country pair. (Source: Anderton & Carter)³⁵

The modelling was carried out in 2014, assuming that the conflict begins in 2014 as year 0. The exact timing of the war is not intended to be specific. We

are interested in generic results for whenever a conflict might break out in future years.

Variable descriptions

The three independent scenarios, described in section two, have been modelled using the Oxford Economics Global Economic Model. Following are the variables in the model to which the shocks were applied. Table 7 provides an overview of the input variables applied.

Inward foreign direct investment is investment in business and capital. China has significant inflows of foreign direct investment and is therefore much more affected by a shock to this variable than Japan. A 40% reduction of inward foreign direct investment represents a loss of approximately US\$ 100 billion per annum to the Chinese economy at its peak in year 2. In Japan this represents a loss of about US\$ 2.1 billion per annum at its peak in year 2.

Government consumption increases during war to pay for military, ammunition and additional resources required for war. China presently spends 2.0% (US\$ 166 billion) of GDP on defence while Japan spends 1.0% (US\$ 59.3 billion) of GDP on defence. In each of the three scenarios government expenditure increased 7% in the first year and then returns to baseline levels by the end of the second year. This represents an increase in government spending of US\$ 86 billion per annum for China and US\$ 70 billion per annum for Japan.

Exports and imports account for a significant share of GDP for both Japan and China. In China Exports account for 26% of GDP and in Japan they account for 18%. One of the largest economic impacts that will occur as a result of this war will result from exports and imports being prevented to entering the East China Sea. Exports and imports are both shocked simultaneously and equally in each scenario. The peak of the shock to exports and imports occurs at the outbreak of war but takes a further six years to recover to pre-war levels.

Capital destruction is defined as capital that can no longer be used as a productive resource and is an expected but unfortunate consequence of war. A declining capital base therefore has very serious consequences for economic output and growth. The level of capital destruction increases in each of the three model variants from 2% of the capital stock in S1, 5% in S2 and 10% in X1.

Share prices capture the market valuation of enterprises within an economy and incorporate the assets on a company's books and the expected value of future revenue and profit. Share prices therefore capture the level of confidence that the market has in the future profitability of a company.

³⁵ Anderton & Carter (2001), "The impact of war on trade: An interrupted times-series study", *Journal of Peace Research*

Any enterprise that operates in a country that is at war will face increasing risk to its normal business operation and long-term strategic objectives. Increased uncertainty about future growth will have significant downward pressure on the market valuation of companies that operate in these areas. Share prices have been shocked 2% in S1, 5% in S2 and 10% in S3 compared to the baseline. In all three scenarios share prices return to baseline by the end of second year after the war began. Share prices are also expected to decrease in other parts of the world as global future expectations are amended downward. These effects are modelled directly on neighbouring Asian countries and the US stock market.

Capital flight occurs when assets and money rapidly flow out of a country or region. Capital flight is most likely to occur when investment and business outlooks are uncertain and investments are placed at risk. In Japan capital flight is modelled as a devaluation of its exchange rate benchmarked against the US dollar. A 10% devaluation of the Japanese currency occurs in S1, 15% in S2 and 50% in X1.

	Variable	S1	S2	X1
FDI	Inward Foreign Direct Investment	Yr1-Yr7	Yr1-Yr7	Yr1-Yr7
		-40%	-60%	-80%
GC	Government Consumption	Yr1-Yr3	Yr1-Yr3	Yr1-Yr3
		+7%	+7%	+7%
X	Total Exports	Yr1-Yr7	Yr1-Yr7	Yr1-Yr7
		-40%	-60%	-80%
M	Total Imports	Yr-Yr2	Yr1-Yr7	Yr1-Yr7
		-40%	-60%	-80%
K	Capital Destruction	Yr1 Q1	Yr1 Q1	Yr1 Q1
		-2%	-5%	-10%
PSH	Share Price (China and Japan)	Yr1-Yr3	Yr1-Yr3	Yr1-Yr3
		-2%	-5%	-10%
RXD (Japan)	Exchange Rate to US\$	Yr1	Yr1-Yr2	Yr1-Yr6
		+10%	+15%	+50%
ILON (China)	Investment from loans	Yr1-Yr7	Yr1-Yr7	Yr1-Yr7
		-40%	-60%	-80%
PSH	Share Price Asian Economies + USA	Yr1-Yr3	Yr1-Yr3	Yr1-Yr3
		-1.5%	-3%	-5%
WPO	World Oil Price	Yr1 (1 yr)	Yr1-Yr3 (2 yrs)	Yr1-Yr3
		+20%	+30%	+50%

Table 7: Input parameter variables in the macroeconomic modeling

Modelling capital flight from China is more problematic. China has strict controls on capital and the Yuan does not float on international currency markets. The exchange rate in China is therefore fixed at present levels across all scenarios. Capital flight in China is therefore indirectly captured through a decrease in investment funded by loans. This is represented by a shock of 40% in S1, 60% in S2 and 80% in X1 with recovery back to baseline projections taking six years.

World oil price typically increases during war due to increased demand for energy and increased uncertainty around supply. This is modelled as a 20% increase in S1, 30% increase in S2 and 50% increase X1. The increase in price lasts for 12 months during the war and then is allowed to return to base during the second year.

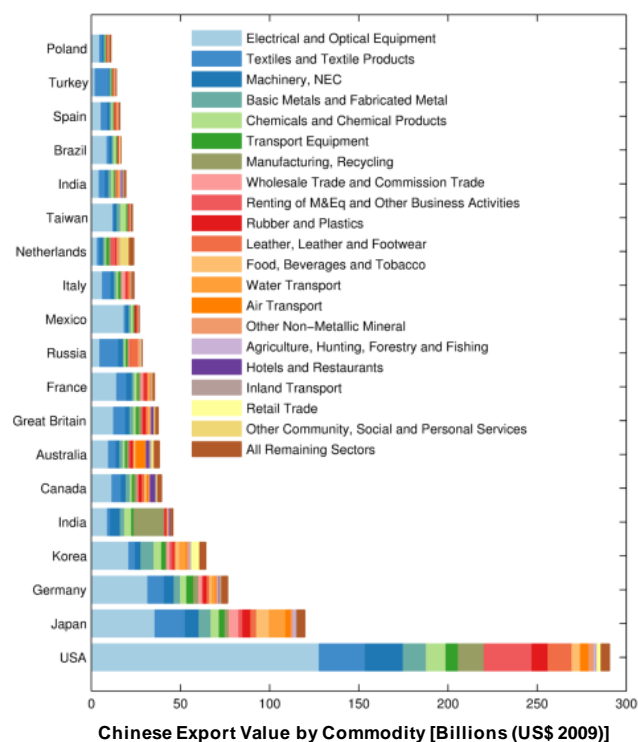


Figure 10: China exports by value and type to different countries

Impact on exports and imports

A shock on exports and imports to China and Japan represents one of the most significant impacts that will affect global economic output. Figures 10 and 11 shows the international exports from China and Japan which are halted by the war. The biggest recipient of exports from the protagonists, apart from each other, is United States.

As a consequence of the war, total exports in China for the year 2 drop by 80% in the X1 scenario or roughly US\$ 1.5 trillion. And for Japan exports drop by US\$ 726 billion. Behind China and Japan exports from the US are the most adversely affected international market dropping in traded value by over US\$ 450 billion in the X1 scenario. Globally, the aggregate value of total exports drops by over US\$ 6 trillion. A similar picture can be told for imports. Imports to the US reach a minimum in year 2 with a drop of US\$ 165 billion while the value of aggregate global imports drops by almost \$4 trillion across all markets and sectors.

Impact on energy prices

Brent crude spot price spikes at US\$ 120 per barrel in scenario X1 and roughly US\$ 110pb in each of the other two scenarios. This occurs despite

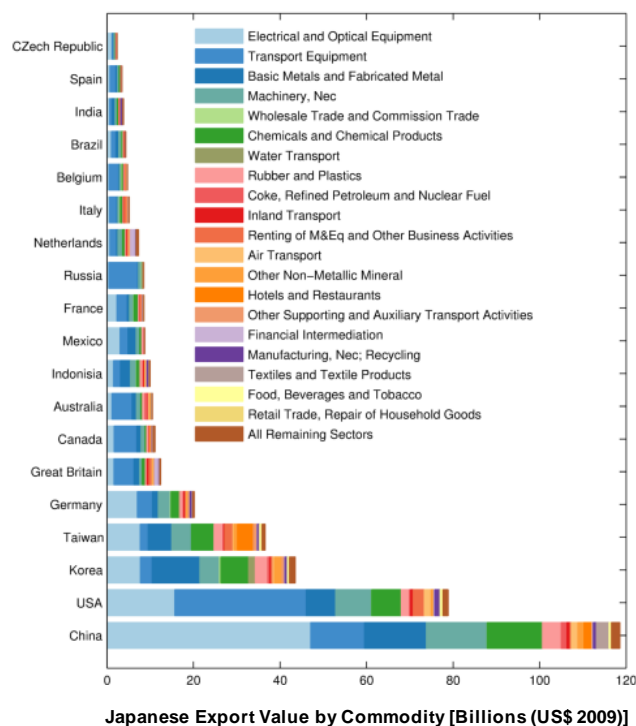


Figure 11: Japan exports by value and type to different countries.

downward pressure on global aggregate demand due to a decrease aggregate output, a substantial shock to global trade and a significant drop in market confidence. The largest impact on global oil price occurs 12 months after the war began with a precipitous decline in oil price as the world recovers from the shock of war. There is then a period of two years of persistent decline in oil price until the end of year 3. Global oil price does not fully recover to pre-war levels by the end of the model period in year 7.

Impact on commodity prices

A similar pattern will occur in the price of most other natural resources and commodities. Prices of raw commodities will initially increase as Japan and China ramp up demand for raw materials and resources in preparation for war. Iron ore, coal, natural gas and other rare earth metals will all spike in price as the threat of war looms. Once a long and protracted war between China and Japan looks unlikely and the international community is successful in getting the peace treaty signed, the price of natural resources will then decline rapidly as aggregate demand decreases. By this point the signs of a global recession are imminent. Aggregate demand is down, trade between Japan and China has ceased and market confidence will be at an all-time low. China, who was once the world's largest exporter, struggles to attract foreign direct investment and cannot find sufficient buyers for its manufactured goods. This leads to lower demand for raw materials, which leads to persistently low prices for raw commodities and resources for the next several years.

Impact on employment

A drop in global aggregate demand leads to a rapid increase in unemployment precipitated primarily by a drop in exports and a loss in the value of share price. In both Japan and China there is a rapid increase in unemployment as the economy adjusts in the post war period between year 2 and year 7. Unemployment in Japan ramps up after the end of the war and peaks at 14% in year 5, 10% higher than baseline. In China the effects of unemployment are much more acute reaching a peak unemployment rate of 9% during the first year, 5% above baseline. Similarly unemployment in the rest of the world is also adversely affected. Unemployment in the US reaches 9.4% in year 3, 2 years after the war has started, 3.8% above baseline projections.

Impact on inflation

Historically, one of the most devastating macroeconomic post-war consequences is high and runaway inflation. Figure 12 shows the effects

of the scenario on inflation in different countries as a result of the conflict, scenario S1.

In the war scenario both Japan and China experience inflationary pressure and a rise in consumer prices precipitated by a combination of cost-push inflation and import inflation. Cost push inflation occurs because important resources and goods are diverted away from the real economy and used for the war effort. Manufacturing plants that once made goods for general consumption are now used to produce items required for war – this drives up the price of normal goods in the economy as there are limited supplies of alternatives. Import inflation will occur because the import of goods from international markets are blocked from coming through the East and South China Seas, with a limited supply of local substitutes, prices for these goods will also increase.

In China prices decrease inline with a drop in aggregate demand, a direct result of a reduction in foreign direct investment. In the most extreme scenario X1 there is a short period of deflation in the Chinese economy, peaking at -1.5%, which is followed by increasing inflationary pressure after the war ends. Inflation peaks at 9.6% in year 4 in the S1 scenario before declining to pre-war levels by year 7.

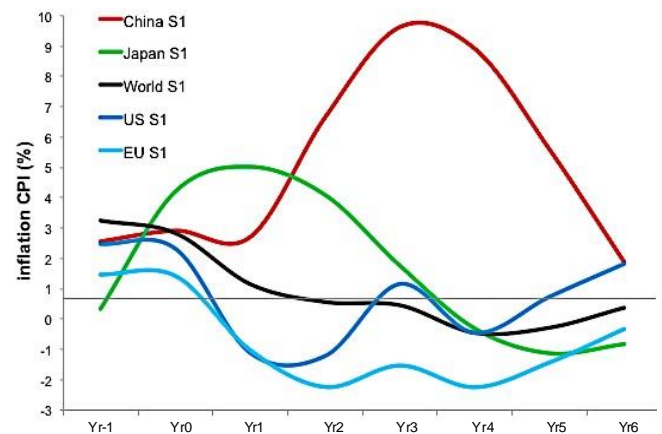


Figure 12: Impact of the conflict on inflation in different countries, in scenario S1

In Japan, where FDI is so small, inflationary pressure accompanies the start of the war. Scenario S1 peaks at 5% inflation in year 2 before going into deflation in year 6. In scenario X1, inflation reaches 20% in year 2 before dropping precipitously back to negative levels (deflation) from year 5 onwards.

The global economy experiences a similar pattern of inflation. During the war, inflation increases and peaks in scenarios X1 and S2 before starting a long decline. Average global consumer prices then decrease for 4 to 5 years before returning to positive growth rates from year 6.

Impact on government balance and reserves

The scenario results in a significant decrease (compared to baseline) in foreign reserves for both China and Japan. In the X1 scenario, the analysis suggests that China and Japan will decrease their foreign reserve holdings by US\$ 2.2 trillion and US\$ 430 billion respectively when compared to baseline by year 7.

Similarly, gross government debt as a percentage of GDP will also increase. In China the debt to GDP ratio approaches 45% under X1 and a little over 30% in S1 by year 7. In Japan the debt to GDP ratio also increases from 212% in year 0 to almost 277% in year 7.

Impact on interest rates

Interest rates are often used exogenously as a policy instrument to influence economic activity. Lowering interest rates gives the economy a boost and encourages borrowing, while increasing interest rates has the effect of slowing down an economy that is overheating. In the scenario, interest rates are allowed to adjust endogenously (not through policy intervention) to reflect economic pressures that are occurring in within the economy. For example, interest rates adjust to inflationary expectations and demand. When inflation is expected to increase in the future, borrowers need to compensate lenders for the expected decrease in the value of money.

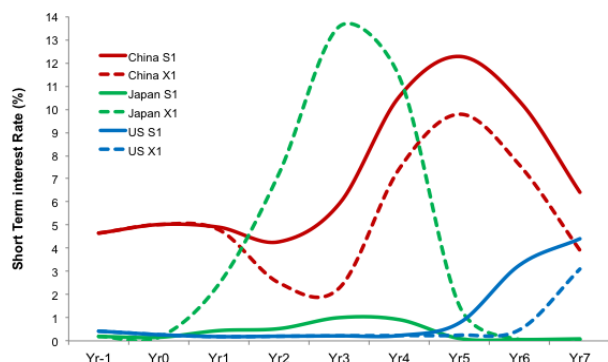


Figure 13: Short term interest rate impacts from the conflict, scenarios S1 and X1.

Inflation in both China and Japan increases over the scenario period, contributing to a rise in the interest rates in both countries. Interest rates also increase because of increased risk. During and after the war both China and Japan experience increased exposure to risk, which puts upward pressure on interest rates.

Exchange rates represent the relative value of a country's currency and are closely correlated with a country's interest rates. In the scenario, Japanese

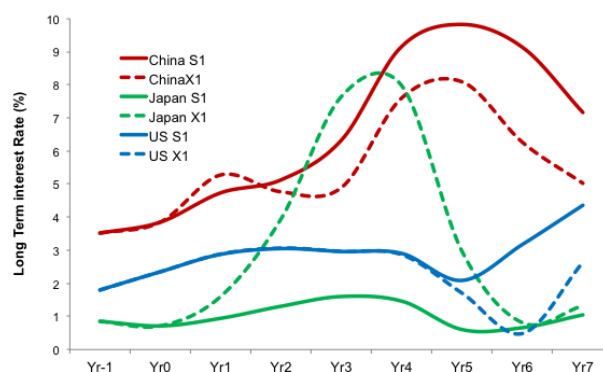


Figure 14: Long term interest rate impacts from the conflict, scenarios S1 and X1.

exchange rates are free to adjust on currency markets, reflecting relative value of the Japanese Yen, whereas China controls its currency on international markets, depressing the value of the Yuan to favour its own exports. The different policy approaches to currency will result in different impacts to interest rates in both countries. In China, where exchange rates are fixed during the modelling period, short term interest rates experience the highest increase under the S1 scenario peaking at a little over 12%. As the Yuan is fixed and therefore not allowed to devalue, the major forces acting on interest rates are dominated by inflation and the money supply. In Japan, where exchange rates are allowed to fluctuate on international markets, high interest rates are caused by an increase on the risk premium of US denominated debt and the lagged effects of the exchange rates impacting consumption and investment. In Japan, therefore, the highest interest rates will occur in the X1 scenario.

As shown in Figures 13 and 14, short term interest rates increase over the medium term before steadily declining. In China, a small decline in short term interest rates for a period of 18 to 24 months after the war began is caused by the drop in foreign direct investment and increase in capital flight. Short term interest rates then begin to rise above baseline projections two to three years after the war started due to rising inflation and an increase on the risk premium of US denominated debt. In contrast, Japan experiences an immediate increase in short term interest rates explained by rising inflation and increased risk premiums.

Interest rates in the rest of the world are represented by the US in Figure 14. Historically, US and UK interest rates behave very similarly. Short term interest rates are shown to decrease and plateau at a little over 0% for four years after the war before rising again. Similarly, long term interest rates decrease to a low of 0.5% and 1.5% in the US and UK respectively in year 6 before growing once again.

Productivity and growth

In all scenarios, both Japan and China enter into recession in the first year of the conflict, year 1. In China, the recession lasts approximately 12 months, with negative growth peaking at -10% in the X1 scenario (Figure 15). In Japan, the recession is much more protracted, lasting five years in the X1 scenario. Globally, the recession lasts 1.5 years in S2 and 2 years in X1 with negative growth peaking at -2%. The war is shown to have a significant impact in terms of lost output.

Table 8 shows the cost of the war compared to baseline over a five year period between the start of year 1 and the end of year 5 for different regional economies. It is notable that the global economic consequences of the war are almost as significant in the US and the EU as they are in Japan and China.

Lost Output over 5 yrs 'GDP@Risk'		S1 9 month conflict		S2 2 year conflict		X1 5 year conflict	
Country	GDP Yr0	5 yr Loss \$Tr	% Yr0	5 yr Loss \$Tr	% Yr0	5 yr Loss \$Tr	% Yr0
China	4.86	4.4	91	5.1	105	6.1	126
Japan	4.77	1.5	31	4.3	90	6.2	130
US	14.50	2.6	18	4.3	30	5.7	39
EU	14.64	2.4	16	4.1	28	5.1	35
World	55.66	17.4	31	27	49	34.2	61

Table 8: Lost output over 5 years from China-Japan Conflict scenario, 'GDP@Risk', US\$ Trillions.

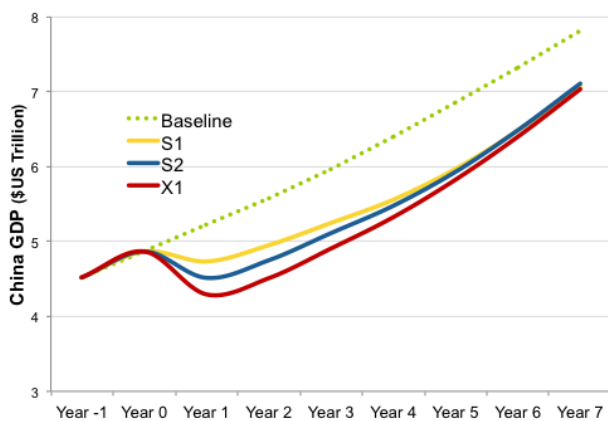


Figure 15: Result of the conflict on China Gross Domestic Product

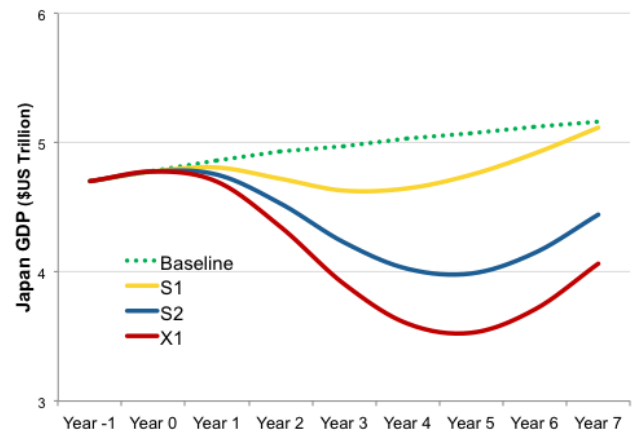


Figure 16: Result of the conflict on Japan Gross Domestic Product

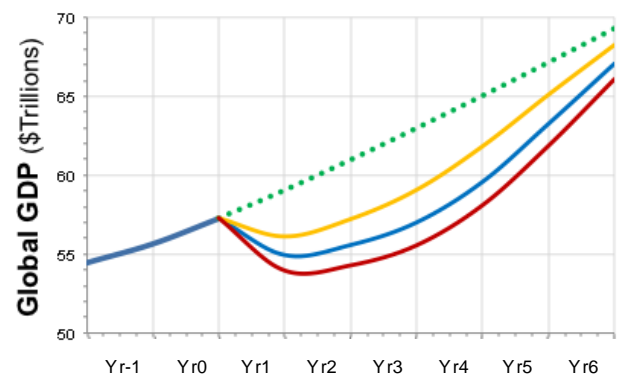


Figure 17: Result of the conflict on Global GDP

GDP@Risk

The macroeconomic consequence of the scenario is modelled as described, using the Oxford Economics Global Economic Model. The impact of the scenario is then compared with the macroeconomic projection of the global economy that is forecast without a crisis occurring, to assess the GDP at risk from this scenario.

The Oxford Economics macroeconomic forecast for the world economy (as of 2014) is for average annual growth of 3.2% sustained for the next decade. This is higher than the average annual growth of 3.0% that the world economy achieved during the boom years of 1980 to 2006, preceding the Great Financial Crisis of 2008-2012. This is a positive outlook, with the size of the global economy reaching \$80 trillion by 2025: around 145% of its current size. The Oxford Economics model is not explicitly probabilistic, but the expected baseline is estimated at the median, or 50th percentile, view of a wide fan of uncertainty of all of the potential future trends that might occur. The reality of economic progress resembles a random walk along the trend, with variation and fluctuations occurring from time to time. Modelled views necessarily present a smoothed view of the

trend, and this is the view we take as the baseline that is likely to occur without a crisis.

When a crisis occurs, such as the geopolitical conflict scenario considered here, there is a significant deviation from the expected trend in GDP growth. Figure 17 illustrates the dip in global GDP that is modelled to occur as a result of the scenario, in all its variants. These are compared with the expected trend without the scenario (the dotted line). The total GDP loss over five years, relative to the expected forecast without the pandemic occurring, defines the 'GDP@Risk' for the scenario. This is expressed as a % of the total GDP for the year ('Year 0') before the occurrence of the event. Table 8 provides the GDP loss of each of the variants of the scenario, as total lost economic output over five years, and as GDP@Risk – the % of Year 0 GDP.

Economics of China-Japan Conflict Scenario

The scenario of a war between the second and third largest economies in the world is estimated to cause the loss of \$17 trillion of global output over a five year period, equivalent to nearly a third of the total GDP of the year prior to its assumed start point. The most extreme variant, X1, is estimated to cause a loss of \$34 trillion, or 61% of the Y0 global GDP. For reference, the Great Financial Crisis of 2007-2012 caused loss of output relative to the trend of global growth prior to the crisis, of \$18 trillion, which is 38% of the Y0 GDP (i.e. 2007 where global GDP reached \$48.1 trillion just prior to the crisis). Scaled to current (2014) GDP values, this would be a GDP loss of \$20 Trillion. The conflict scenario causes economic loss comparable to the Great Financial Crisis of 2007-2012. The X1 scenario – a five year war - causes losses to the global economy that are much more severe than the Great Financial Crisis: an estimated GDP@Risk that is 1.6 times larger.

The projected impact is of course particularly severe for the combatants themselves.

Impact on China

China's loss of output over the five years is equivalent to more than 90% of its GDP in the year before the conflict. The scenario variants increase this to 126% of a year's output in the longer duration X1. The big impact for China is the outbreak of conflict, rather than the duration. Once China's exports have been interrupted, customers around the world might be expected to find alternative suppliers, and demand does not return to former levels. The GDP scenarios for China see growth eventually restored, as many of the fundamentals that are driving China's economic growth are still operating, but by year 7 they have not caught up with the baseline

trajectory of growth they are expected to achieve without the conflict.

Impact on Japan

Japan is impacted differently to China. A short conflict, scenario S1, has a significant impact on the economy: over the five years it loses the equivalent of just under a third of its GDP in the year before the conflict. However, Japan's economic impact is very sensitive to the duration of the conflict, and the interruption it brings. A two year conflict, S2, sees Japan's lost output increase to 90% of GDP in year 0, and a five year conflict, to 130%. In the short duration S1 scenario, the Japanese economy has almost completely recovered to where it might otherwise have been by year 7, but in longer duration scenarios, the economy is so badly affected that it may take many years after the scenario window for it to recover, if ever.

Economic conclusions

A conflict of this severity clearly has very significant implications for the global economy.

In this analysis we have demonstrated how the disruption of trade links with the rest of the world causes cascades of consequences that affects all the major economies. The conflict that takes place within a small geographical region reverberates around the globe to affect almost every major economy.

The network visualization image on the back cover of this report illustrates the impact on GDP for every major economy in the world of the China-Japan conflict. It depicts the size of each national economy, the trading interlinkage between them, combined with the colour-coding of the country by how much change in GDP is caused by the conflict in scenario S1. The ripples of consequence are critical dimensions of this scenario. If this scenario had occurred even twenty or ten years ago, it would have been much less consequential for the rest of the world because the connectivity of the global economy to southeast Asia was much less developed.

And perhaps this very interconnectivity means that such a conflict will never occur. The penalty for any combatant in a major conflict is very high, and clearly international vested interests will apply the maximum pressure to diffuse any rising confrontation because of the impact it could have. The counter to this is that closely linked trading partners have gone to war historically, despite it being extremely counter-productive for them to do so. In section 5 we present the historical precedent study of the major trading partners, Britain and Germany, going to war in 1914.

This conflict shows how the repercussions would flow through the global economy, not least the duration of the consequences. Many of the fundamental drivers of the global economy are not altered, so after some disruption, growth is resumed and pent-up or deferred demand may even drive faster levels of growth than might otherwise have occurred. The trajectories of global GDP show some closing of the gap later on between where the baseline of global GDP would be without the war, and the major reduction in GDP that the conflict causes. However, the scenario causes permanent loss. The world economy never fully recovers to where it would

have been without the conflict occurring, but is reset to a new, lower point from which growth resumes at similar rates, so the world economy is permanently diminished by the outbreak of the war.

The factors that make the scenarios worse themselves combine in non-linear and escalating ways. The metrics of loss, as shown by the GDP@Risk values for the different variants do not scale very easily – the five year conflict in X1 causes double the output loss of the nine month conflict, S1. As noted above, the duration of conflict is more important to some economies, in particular Japan.

7 Investment Portfolio

Introduction

The macroeconomic effects of the China-Japan conflict – causing major reductions in global outputs and extended periods of recession – will have an inevitable effect on the capital markets. This section considers the market impact of the conflict, and the consequences for investors in the capital markets.

The performance of equities and bonds in different markets are estimated from the macroeconomic consequences, and compared with a baseline projection of their expected average performance that would result from the economic projections without the conflict occurring.

Valuation fundamentals

Note that these are estimates of how the fundamentals of asset values are likely to change as a result of these market conditions, as directional indication of valuation. This analysis is not a prediction of daily market behaviour and does not take into account the wide variations and volatility that can occur to asset values due to trading fluctuations, sentiment, and the mechanisms of the market.

The winds of war between China and Japan are likely to cause a downturn in stock markets all around the world. Investors are likely to turn to assets that are perceived as safer, such as sovereign bonds of non-belligerent countries. The increase of demand for sovereign bonds is expected to translate into higher prices, and therefore lower yields for these assets. The macroeconomic modelling of some of the more extreme variants of the scenario suggests a drop of stock indices of 50% and yields on 10-year US government bonds to be reduced up to a factor of two with respect to baseline.

China holdings of US debt

A key issue for the investment implications of this scenario is the amount of US debt that China holds.

According to the World Bank at the end of 2012 China held reserves for about 3.3 trillion US dollars³⁶. Although China does not disclose the composition of its foreign exchange reserves, the consensus is that 60-70% of the reserves are invested in US dollars, 20-30% in Euro, 10% in British pounds, Japanese yen and other

currencies³⁷. Depending on China's investment strategy we could expect significant changes in exchange rates. For instance, if China decided to liquidate part of its share of US debt, we could expect a significant devaluation of the US dollar.

A standardized investment portfolio

We explore the impact of the market change by considering the performance of a standardized, hypothetical investment portfolio. Every investment portfolio has a different structure and balance. The impact on each asset class is presented below, to assist with assessing how these projected market changes apply to an individual unique portfolio.

The standardized investment portfolio is based on a structure that is focused on high quality and fixed income assets, of the type that major insurance companies hold.

We consider a high-quality fixed-income portfolio with about 85% of investments in sovereigns and corporate bonds most of which are investment grade, rated A or higher.

Details of the standardized investment portfolio are shown in Table 9 and Figures 18 to 20.

Long-term bonds are assumed to have an average maturity of 10 years, while short to medium bonds have a maturity of 2 years for US, UK and Japan, and 3 months for investments in the Eurozone.

Investments are spread across countries like the US, UK, Eurozone, Japan and emerging markets.

Typically the geographical market structure of an investment portfolio for an insurance company is carefully matched to the geographical locations of their underwriting exposures, to minimize exchange rate risk. Different insurer geographical exposure will result in different market distributions.

Portfolio structure	USD	GBP	Euro	Yen	Other	Total
Government med/long	8%	7%	5%	2%	2%	24%
Government short	6%	5%	4%	2%	3%	20%
Cash	2%	1%	1%		1%	5%
AAA short	2%	2%	2%	1%	1%	8%
AAA med/long	4%	3%	1%	1%	1%	10%
AA short	1%	1%	1%			3%
AA med/long	2%	1%	1%		2%	6%
A short						0%
A med/long	2%	2%	2%	2%		8%
BBB and lower	2%	2%	1%		1%	6%
Equities etc	2%	2%	2%		4%	10%
Total	31%	26%	20%	8%	15%	

Table 9: Standardized Investment portfolio structure

³⁶ World Bank
<http://data.worldbank.org/indicator/FI.RES.TOTL.CD>

³⁷ Hu (2010).

Equities compose about 10% of the investment portfolio. We assume for simplicity that equity investments correspond to stock indexes.

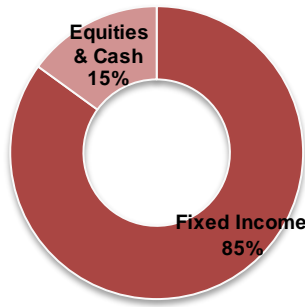


Figure 18: Asset classes in standardized portfolio: high proportion of fixed income

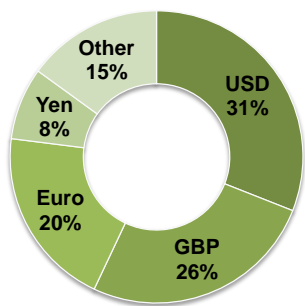


Figure 19: Geographic market spread of standardized portfolio

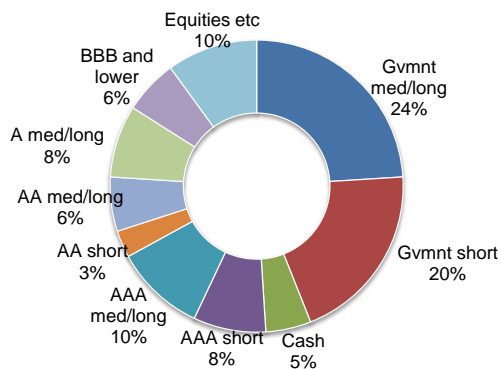


Figure 20: Assets and ratings of standardized portfolio

Computation of returns

The return for the portfolio is estimated using standard methods³⁸ as outlined in the following.

³⁸ See Government of Singapore Investment Corporation (2011) for a study that uses a similar methodology

For each bond b , the return $r_b(t)$ at time t is computed as:

$$r_b(t) = y_b(t) + g_b(t)$$

where $y_b(t)$ is the bond yield and $g_b(t)$ the capital gain.

The yield on government bonds is taken from the output of the macroeconomic analysis presented in the previous section. For corporate bonds the yield is computed adding a credit spread to the yield of government bonds with corresponding maturity. The values used for credit spreads are reported in table 10, and are similar to those reported for US corporate bonds in 2006 (tests show that the qualitative pattern of results discussed below is robust with respect to changes in credit spreads up to a factor of 2).

The capital gain is computed from bond yields as

$$g_b(t) = -D_b [y_b(t) - y_b(t - 1)].$$

where $-D_b$ is the bond duration, for which we assumed the following values: $D_b = 7$ for ten years bonds, $D_b = 1.8$ for two years bonds and $D_b = 0.4$ for bonds with maturity of three months. In our analysis we assume no default on sovereign bonds, while defaults on corporate bonds are accounted for through the introduction of a discount factor that calibrated to obtain in the baseline scenario the default probabilities shown in Table 10.

For the stressed scenarios we assumed that default probabilities increase by a factor of 3. The qualitative pattern of the results derived are robust with respect to changes in this assumption.

Credit rating of corporate bond	Credit spread (bp)	Default probability (per year)
AAA medium/short	16	0.52%
AAA long	68	0.52%
AA medium/short	37	0.52%
AA long	80	0.52%
A long	51	0.29%
BBB and lower	95	2%

Table 10: Credit spreads and default probabilities for corporate bonds

Stock returns are computed as

$$r_s(t) = y_s(t) + g_s(t),$$

where $y_s(t)$ is the dividend yield of stock s and $g_s(t)$ its capital gain.

The latter is computed from the stock price $p_s(t)$ as

$$g_s(t) = \frac{p_s(t) - p_s(t-1)}{p_s(t-1)}.$$

The macro-economic model produces a forecast for dividend yields of UK stocks, that we assume to be similar to those of US and Eurozone stocks.

The return on the whole portfolio is then computed taking a weighted sum over the returns of all assets.

Passive investor assumption

The analysis results are presented assuming a passive investment strategy. This means that the portfolio retains its structure and remains constant throughout the scenario, without any response to the performance of the assets within it, or portfolio rebalancing. This assumption is unrealistic, as we expect an asset manager to react to changing market conditions to reduce losses and large fluctuations in returns. However this assumption enables us to benchmark the performance for a fixed portfolio to use as a metric to observe the market changes.

Understanding what drives the behaviour of the fixed portfolio over the timeline of the scenario can, for instance, give useful insight towards the design of optimal investment strategies.

Results

Results of our analysis are presented in Figures 21–24. In Figure 21 we plot, for the different variants of the scenario, the percentage change of portfolio returns with respect to the baseline. In all cases we observe significant departures from the baseline. Increasing the severity of the macro-economic shock increases the amplitude of the deviation from the baseline. The investment portfolio under the China-Japan conflict scenario overall underperforms with respect to the baseline, with negative peaks around -80% in Year 1 and 100% after Year 6. Interestingly, we observe that under the most extreme variant of the China-Japan conflict scenario the investment portfolio even registers significantly higher (up to 20%) returns with respect to the baseline in Years 4-5. Such gains are then counterbalanced by a negative -110% peak in Year 6. Similar patterns are observed also for the less extreme variants of the China-Japan conflict scenario, for which we also observe performances comparable to the baseline around Year 5 before significant negative peaks in Years 6-7.

A better estimation of the overall performance of the investment portfolio is represented in Figure

22, where the percentage change is plotted over

time with respect to the baseline of cumulative returns. The cumulative return at time t is computed as the sum of returns up to that time. From Figure 22 we see that, by the end of the simulated time period, total losses with respect to the baseline range from around 15% for the S1 scenario to 20% for S2 and X1 scenarios. In all variants investment portfolios display losses with respect to the baseline. Losses are concentrated in two time windows, the first before Year 3 and the second after Year 5. In both these time windows, losses with respect to the baseline seem to occur approximately at a constant rate for the three scenarios.

The last part of our analysis is devoted to understanding the impact of the China-Japan conflict scenario on different asset classes. The aim of this exercise is that of identifying which assets are responsible for the losses of the investment portfolio with respect to the baseline. Figures 23 and 24 summarize this analysis for the S1 variant of the scenario. Figure 23 shows a breakdown of the portfolio performance by countries. Investments in the US, UK, and EuroZone are responsible for most of the losses. Figure 24 presents a breakdown of the fixed income and equity components of the investment portfolio. Equities are responsible for the first negative peak in Year 1, while losses in the second downturn of Year 4 are mainly due to fixed income investments.

Similar conclusions concerning the importance of different groups of assets can be drawn for the other variants of the China-Japan conflict scenario, S2 and X1.

Conclusion

The output from the macroeconomic model has been used as an input to assess the performance of a representative high quality investment portfolio. The performance of the portfolio under the different variants of the scenario is compared with the expected performance without the event, as the baseline.

Table 11 gives a summary. Under all variants of the scenario, the investment portfolio registered significant losses compared to the baseline. In the short term (12-18 months), cumulative losses reach 5%. More significant losses are registered in the long-term (5-10 years), where cumulative losses reach 15-20%.

We take a passive asset management strategy to provide a benchmark for comparing more complex asset management strategies.

Although the analysis presents different variants of the scenario to give an idea of sensitivity, it has not

been possible to systematically test the stability of results with respect to the parameter settings used to develop the scenario. A systematic evaluation of all the uncertainties in the analysis approach would be useful in the future.

Scenario	Cumulative loss from baseline: short-term	Cumulative loss from baseline: long-term	Short-term maximal loss from baseline	Long-term maximal loss from baseline
S1	4%	13%	60%	100%
S2	5%	15%	70%	120%
X1	6%	20%	80%	120%

Table 11: Summary of results on estimate of losses with respect to baseline.

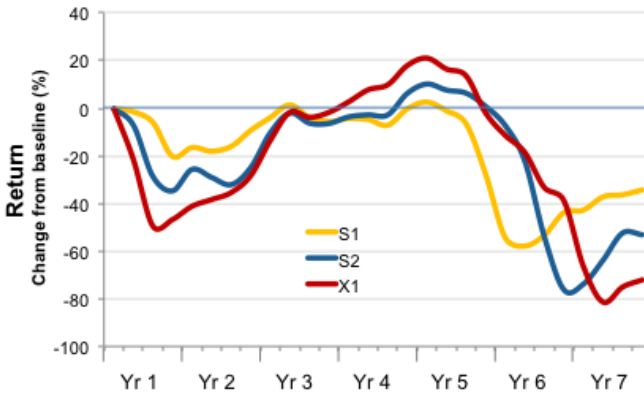


Figure 21: Percentage change with respect to baseline of portfolio returns under different scenarios.

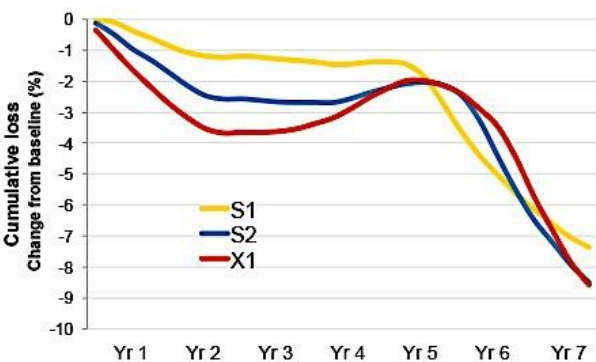


Figure 22: Relative change of cumulative returns with respect to baseline.

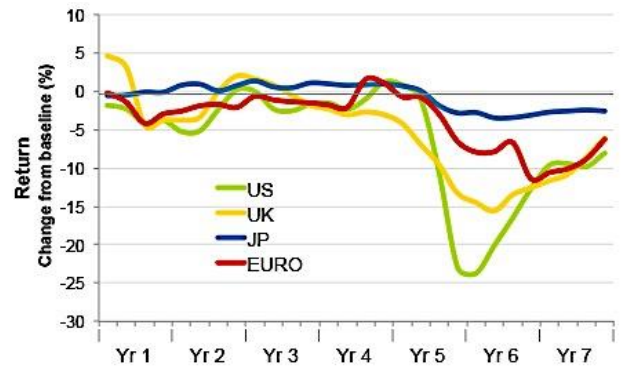


Figure 23: Percentage change with respect to baseline of investments down by countries (S1).

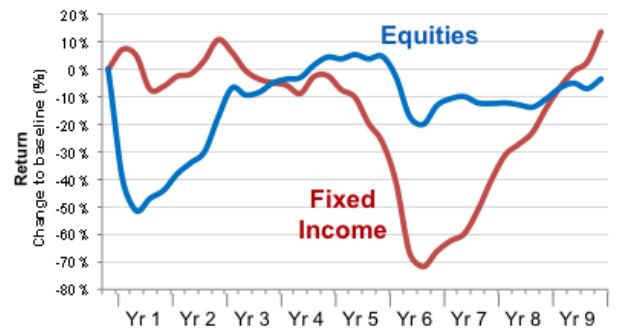


Figure 24: Percentage change with respect to baseline of investments in fixed income and equities (S1).

Equities are responsible for short-term losses, while bonds dominate the second negative peak.

Correlation

A general approach to apply these representative asset shocks to a portfolio of many other assets types is to assume a correlation structure across the full asset range – i.e. how each class of asset is likely to behave relative to these representative asset classes.

Note however, that during a major financial crisis, such as this conflict would undoubtedly trigger, the correlations between assets tighten and converge. Applying an assumption that the correlations would be similar to those observed in non-crisis routine trading could lead to underestimation of the impact.

				Base Levels	Short Term Impact (Δ Max)			Long Term Impact (Δ Max)		
				Yr0Q4	Yr1Q4			Yr3Q3		
				B0	S1	S2	X1	S1	S2	X1
US										
Bonds Short	TSY 2Y	Interest rate, 2-year T-notes (levels)	Δ	0.3	-0.041	-0.038	-0.033	-1.63	-1.657	-1.663
Bonds Long	TSY 10Y	Interest rate, 10 year government bonds (levels)	Δ	2.7	-0.053	-0.050	-0.044	-1.60	-1.64	-1.65
Equities	S&P	Share price index (% change)	%	100	-9.24	-15.0	-21.7	-22.19	-37.3	-46.0
Credit	YSA CSPA	Credit spreads, period average (levels)	Δ	0.3	0.132	0.2280	0.348	0.09	0.199	0.24
Inflation	USA CPI	Consumer price index (% change)	%	100	-0.057	-0.183	0.325	-5.26	-8.18	-9.13
UK										
Bonds Short	GBP 2Y	Interest rate, 2-year T-notes	Δ	0.5	-0.288	0.274	-0.258	-1.78	-1.72	-1.68
Bonds Long	GBP 10Y	Interest rate, 10 year government bonds	Δ	2.8	-0.191	-0.172	-0.151	-1.71	-1.65	-1.61
Equities	FTSE	Share price index	%	100	-2.7	-4.32	-6.17	-3.5	-9.47	-12.43
Credit	GBP CSPA	Credit spreads, period average	Δ	0	0	0	0	0	0	0
Inflation	GBP CPI	Consumer price index	%	100	0.377	0.316	1.277	-5.67	-8.53	-9.98
Foreign Exchange	USD/GBP	Exchange Rate (US\$ £GBP)	%	1.6	-1.18	-1.15	-1.15	0.96	2.12	3.37
Germany										
Bonds Short	DEM 2Y	Interest rate, 2-year German gov bond yields	Δ	0.2	-0.062	-0.035	-0.014	-0.78	-0.73	-0.68
Bonds Long	DEM 10Y	Interest rate, 10 year German gov bond yields	Δ	1.8	-0.056	-0.026	0.003	-0.846	-0.77	-0.73
Equities	DAX	Share price index, Deutscher Aktien Index	%	100	-2.2	-4.1	-6.1	-9.16	-15.8	-18.5
Credit	DEM CSPA	Credit spreads, Period Average	Δ	1.8	0.036	0.066	0.098	0.026	0.072	0.073
Inflation	DEM CPI	Consumer Price Index, Germany	%	100	-0.056	-0.261	0.264	-11.4	-16.4	-18.99
Foreign Exchange	USD/EUR	Exchange Rate (US\$ per Euro)	%	1.3	-0.7	-0.68	-0.67	2.51	4.65	6.85
Japan										
Bonds Short	JPY 2Y	Interest rate, 2-year Japan gov bond yields	Δ	0.1	0.378	1.135	2.131	-0.878	2.55	4.47
Bonds Long	JPY 10Y	Interest rate, 10 year Japan gov bond yields	Δ	0.6	0.286	0.842	1.587	-0.78	2.97	5.60
Equities	NIKKEI	Share price index, Nikkei 225	%	100	-9.44	-20.88	-40.217	-8.68	-30.5	-54.97
Credit	JPY CSPA	Credit spreads, Period Average	Δ	0.2	0	0	0	0	0	0
Inflation	JPY CPI	Consumer Price Index, Japan	%	100	3.69	11.27	20.0	9.89	52.36	86.27
Foreign Exchange	USD/JPY	Exchange Rate (US\$ per JPY)	%	0.013	-27.06	-57.89	-73.39	-28.28	-68.9	-76.3

Table 12: Short term and long term impact on representative portfolio assets from all pandemic variants.

8 Managing the Risk

We have made the case in this report that wars have punctuated human history, and despite a long recent period of peace the threat of war continues to pose a serious risk to our society and to the economic prosperity we currently enjoy. We advocate that organizations should have risk management plans that incorporate the possibility of wars disrupting their activities, and that wars shouldn't be a surprise.

This scenario is offered as an example stress test that organizations can use to consider how a future conflict could disrupt their activities and how to improve their resilience to such a scenario. It illustrates an example of the type of impact that wars could have in the present day. The example starts by considering the type and severity of geopolitical conflict scenario that could be expected with a 1% probability of exceedance per year – a '1-in-100' type of event.

Preparedness for different types of conflicts

We argue that this level of annual probability depicts a 'magnitude 3' conflict, i.e. a regional war between a major military power (China) and ally (Japan) of another major power (US). We explore this scenario and describe one particular way that it might play out.

It is not the only scenario for this magnitude of conflict. Other candidates include potential conflicts in the Middle East, a Russia-Eastern European regional conflict, a conflict between North and South Korea, and other flashpoints that arise from time to time. Management of the risk of conflicts will recognize the wide range of geographical locations, geopolitical actors, and attributes of conflicts that can occur.

Wars are occurring at some level of intensity in some parts of the world most of the time. Most wars are fought in territories where our business activities and national interests are not threatened. However, every so often a conflict occurs in, or spills over into, a part of the world that directly affects our interests and operations. The more global that we become, the more locations there are where conflicts could affect our interests.

Where might it occur?

A global organization should review the territories where it does business and consider the frequency of occurrence of different types of geopolitical disruption that it might expect in those parts of the world. As an organization it should then plan around, and expect to have to manage, a conflict-related crisis somewhere in one of the higher risk

territories where it does business every few years. An enterprise's ten year business plan might for example expect to have a high chance of needing to manage the business through a localized conflict somewhere in the company's territories of interests during that ten year outlook.

It should also consider that there is about a 10% chance that the organization will need to manage through a conflict about as severe as the one depicted in this scenario within that same 10 year outlook. There is also a small but feasible chance that the business may have to face an extreme conflict that would be much worse than the one described here, and would be intensive and widespread.

Managing the risk of conflict disruption means being prepared for a wide range of different types of conflict, not just the scenario described in this report. The objective of considering a stress test scenario of this type is to be resilient across a range of potential crises that could occur, rather than being focused on the scenario itself.

Prediction vs preparedness

Conflicts occur after a period of rising tension. This rising tension can be monitored and is indicative of a potential for a future conflict. Indicators of potential future conflicts include the aggressiveness of official communiqués from the potential protagonists, the deployment of military forces, market pricing of financial assets in affected markets, social media communications, and other signals of growing social tension. These can be used by risk managers to assess when they might implement contingency plans to mitigate the potential impact of the impending conflict.

Risk managers differentiate between long term preparedness and short term contingency measures. Long term measures might identify regions of the world with potential for conflict some months or years ahead, and use this risk assessment in the strategic deployment of resources (such as geographical structuring of business operations, supplier locations, managing an international investment portfolio, or underwriting portfolio, and other business planning). Short term measures might involve actions with only days' or weeks' notice, to carry out contingency plans such as evacuation of personnel, logistical redeployments, emergency purchasing or finding alternative suppliers, rapid restructuring of investment portfolios, or changing contractual conditions.

More potential conflicts than actual conflicts

With short term measures, the difficulty is balancing the precautionary principle with false alarms that are themselves costly and undermine confidence in the risk management process. Rising geopolitical tension does not often lead to a conflict. There are more occurrences of rising geopolitical tensions that are diffused, as rational views prevail, than those that result in an actual conflict. False positives are more likely than correctly predicted outbreaks.

Human nature however is unforgiving in the balance between uncertainty beforehand, and the event in retrospect. Public opinion, political outcry, inquests, and legal judgments increasingly assume that events that did occur were predictable, and are becoming less tolerant of uncertainty and judging probabilities beforehand. Companies that have developed clear rules and protocols for dealing with these uncertainties have more defense after the event.

The triggering of a conflict is not easily predictable. There are many cases where a conflict outbreak has caught most people by surprise. In approaching the issue of managing this risk, it is worth assuming that the process is a random occurrence with a low probability. Don't expect to forecast it beforehand, but have contingency measures in place to move quickly and decisively to mitigate the consequences when it occurs.

Organizations

Conflict threat is principally a threat to the trading continuity of organizations, with the potential to disrupt the transportation of goods around the globe, to impact markets, and to affect suppliers and activities in different regions of the world.

Companies with well-considered contingency plans prepared in advance will be better equipped to manage the operational risk posed by a regional conflict.

Choke points and concentration risk

Contingency plans would include alternative methods and routes for getting goods to market, and people to their business locations, particularly through key chokepoints of international transportation. This scenario demonstrates the importance of the South China Sea as a key chokepoint for shipping routes. There are many other shipping chokepoints that companies should review their use of, and develop contingency plans in case they could become embroiled in conflicts, including the Malacca Straits, the Straits of Hormuz, the Panama and Suez canals, the capes and the northern shipping routes.

Diversification and over-dependence

Concentration risks are also highlighted in this scenario, for example the concentration of electronics manufacturing and assembly in the region we selected for our conflict causes significant problems for the IT industries of Europe and United States. Diversification of suppliers more internationally would make these industries more resilient to regional threats.

Dependency and uniqueness of components is also a strategic issue – the ease with which the suppliers of products and components might be substituted for others could be a consideration in business risk management, with implications for design and procurement.

Counterparty risk

In addition to considering how the crisis might affect the organization itself, consideration should also be given to how business counterparties might be impacted. Some counterparties may be so badly affected that they are unable to continue trading. Credit risk tolerance and cash flow planning should apply stress test scenarios like this one to develop good financial risk management practice for this contingency.

Currency exchange risk

Financial challenges include currency exchange rate risks, and potential for entire countries to change as markets for an organisation's products and services.

Workforce protection

A primary responsibility is obviously the wellbeing of the workforce. Ensuring that they are protected from injury, and as far as possible removed out of harm's way is important. Information is vital in dealing with the emergency period. Ultimately a severe crisis may make even the information infrastructure fail. The 'fog of war' is equally applicable to crisis response, and managers often have to make decisions without reliable information about everything that is happening.

Rapid recovery and business resumption

As the crisis unfolds, management will need to make hard decisions, involving trade-offs between different areas of business losses, and costs and liabilities. Making this decision based on clear guidelines drawn up beforehand is better than improvised or localized decisions. Studies of business crises have demonstrated that organizations that have good recovery plans to restore business operations quickly can gain major competitive advantage over rivals when several are affected by the same event.

A risk management culture

Developing a risk management culture in an organization requires constant awareness raising that these kinds of crises are possible, and having plans and rehearsals for response to an event of this type.

Overall, the long term financial planning for an organization needs to recognise that disruption from a wide range of causes can and will occur from time to time. Although difficult to quantify, these risks do need to be planned for, and incorporated into the management of the business. Ultimately it may be that extreme risks need to be reflected on balance sheets.

This report is intended to contribute to the awareness raising and disaster planning process for the risk management of an organization.

Insurance companies

Insurers face the operational risk management issues of a sizeable organization, and in addition have to deal with the reporting and settlement of claims during a crisis of this type, as well as managing the impact to their investment portfolio.

Act of War exclusions

This report has highlighted that insurers will rely heavily on their Act of War exclusion clauses in their policy contracts to reduce the losses they might be exposed to, so ensuring that these are robust is a vital part of preparedness for geopolitical conflict threats.

We have also argued that it might be prudent not to rely on exclusion language as the principle or only form of risk management. Providing coverage for certain risks that might flow from conflicts may even be a business opportunity, if well managed.

Unexpected claims areas

In addition, there are many lines of insurance business that will suffer claims as a result of a scenario like this one. Some of them are in lines where they might not be expected. This scenario study has tried to explore areas of possible surprise.

Risk transfer

Understanding how unexpected losses might arise enables strategies to manage them, ranging from risk transfer, reinsurance or retrocession arrangements, appropriate capital allocation and aggregation limit controls, improved contractual conditions, and pricing adequacy to cover potential loss.

Multiline correlation and capital models

Capital models of multi-line insurers take silos of insurance business lines to have loss correlations. This scenario challenges that assumption by providing this example where losses correlate across multi-line exposures and accumulate in lines without war exclusions. We also show that the asset side of the business will be affected in the same scenario, so full capital modelling should include asset and underwriting loss correlation in these kinds of events.

Incorporating conflict into business planning

As discussed in this report, human conflict is not a peril that lends itself very readily to conventional probabilistic analysis. Capital models do not today include explicit allocations for these unrecognised risks, but there are clearly classes of unmodelled risks for which losses can occur that need to be incorporated into the risk management processes of an insurer.

This report is intended to add to awareness-raising of these less-well-understood risks by insurers.

Investment managers

This exploration of a specific conflict scenario demonstrates that there will be a significant impact on the markets and that the managers of investment portfolios will see significant losses across major asset classes. Investors will typically pursue their classic ‘flight to quality’ strategies during these major market movements.

Wars are not unknown to the money markets. Investors who have historically seen the market cycle rise and fall through a conflict say that a rule of thumb is to “sell on the trumpets and buy on the cannons” – i.e. to expect the market to fall during the posturing and threatening stage when war looms amid a lot of uncertainty, and to expect the market to rally once war actually breaks out and the uncertainty comes to an end.

Performance of different asset types

The likely patterns of investment asset impact are described in this report for the assumptions made here for this specific scenario. Different markets, investment instruments, rating grades, currencies, and credit spreads are affected. Investors can create portfolios that are able to offset and hedge some of these expected movements. Many investors structure their portfolio to pursue an investment return strategy but also to be resilient to major market shocks of this type, including the ability to rapidly move positions and to create liquidity in crisis situations.

Financial liquidity crisis

If the banking system is in a vulnerable situation of low liquidity or unstable leveraging, then the shock from the macroeconomic losses that result from this scenario is likely to trigger a cascading failure of the financial market system. The more extreme variants of the scenario will almost certainly trigger defaults of major corporations and these could potentially cause liquidity shortages among their counterparties and a general credit crisis that could escalate across the international financial system. In these kinds of financial crises, price plunges of investment assets are highly correlated.

Winners and losers

In the industrial sectors of the equity markets, there are some winners along the losers. Aerospace and defense industries being among the obvious winners, but studies of the distributive effects of wars³⁹ also show that sectors which offer less risky alternatives during a period of political uncertainty also benefit. These include pharmaceuticals, consumer and food, energy companies, and utilities. Losers include travel, airlines, and tourism.

The market will take some time to recover and different asset classes will perform in different ways and at different rates throughout the process.

Long term strategies

The longer term effects on interest rates and inflation consequences will play out through over time. An investor who understands the way that these macroeconomic consequences are likely to unfold will be able to manage their investment portfolio anticipating some of these swings.

Policy-makers

The threat of war and prevention of conflict has long been a major focus of international policy-makers, and many mechanisms now exist for providing outlets for grievances, resolution of disputes, arbitration, and directing multinational action to minimize the actual outbreak of conflicts. These mechanisms, together with the interconnectivity provided by global commerce, have succeeded in ensuring a lengthy period of peace in recent history.

Everyone is a stakeholder in foreign conflicts

National governments may not fear participating in a conflict, or being dragged into one, but it is clear that conflicts elsewhere in the globe can have significant effects on the trade environment for that country, and potentially for the essential supplies and services that the population relies on.

In this scenario, imports and exports were affected for almost all of the other countries of the world, as a result of the conflict between two other nations. The image on the rear cover of this report demonstrates this, depicting the world's economies and their trading relationships, with each country being colour-coded by the amount of economic impact that our hypothetical scenario causes in lost GDP.

Understanding linkages and dependencies

Trade linkages that are vulnerable to conflicts may not be obvious without analysis. Countries may also not realise the extent to which their primary trading partners may be reliant on another trading relationship with a third country which is in turn vulnerable to disruption from another source of conflict.

National food and energy security

Essential food and energy supplies may be vulnerable to disruption from wars, and the supply chain of national essentials may be as vulnerable as corporate supply chains to transportation disruption, congestion at choke points, and concentration risk of suppliers. At a national level, civil protection plans may need to consider issues of diversification of suppliers and strategic distribution concerns.

Conflict as an emerging risk

We argue that the threat of conflict is of sufficient magnitude to be taken very seriously by everyone. This risk has implications for individual organizations, insurance companies, investment managers, and most critically of all, to the national and international policy-makers who need to address this threat.

We offer this report as a way to highlight the risk, and to encourage actions by all of the major stakeholders in managing this risk and making the world a safer place from the impact of future conflicts.

³⁹ Schneider and Tröger (2004).

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