EDUCATION COMMITTEE

OF THE

SOCIETY OF ACTUARIES

QUANTITATIVE FINANCE AND INVESTMENT

INVESTMENT RISK MANAGEMENT STUDY NOTE

MISSING PAGES FROM

STRESS TESTING AND SCENARIO ANALYSIS (pp. 34-39)

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International Actuarial Association

The Education Committee provides study notes to persons preparing for the examinations of the Society of Actuaries. They are intended to acquaint candidates with some of the theoretical and practical considerations involved in the various subjects. While varying opinions are presented where appropriate, limits on the length of the material and other considerations sometimes prevent the inclusion of all possible opinions. These study notes do not, however, represent any official opinion, interpretations or endorsement of the Society of Actuaries or its Education Committee. The Society is grateful to the authors for their contributions in preparing the study notes.

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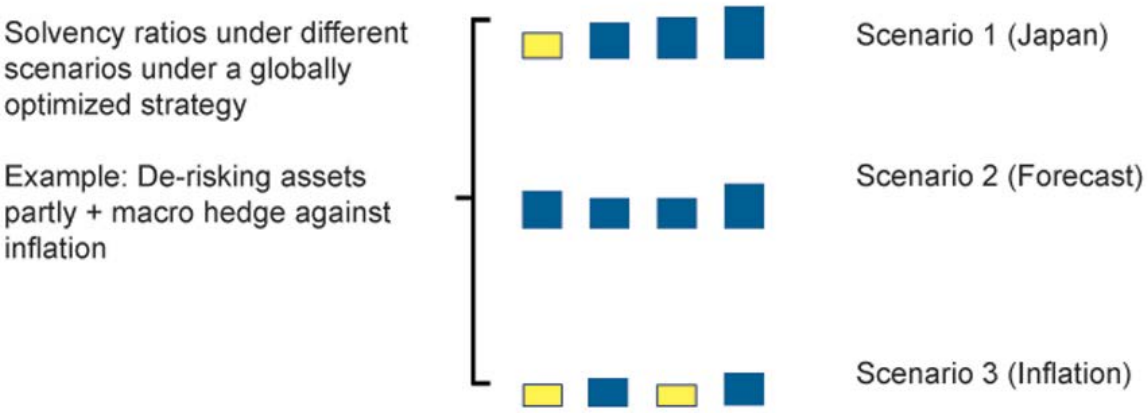
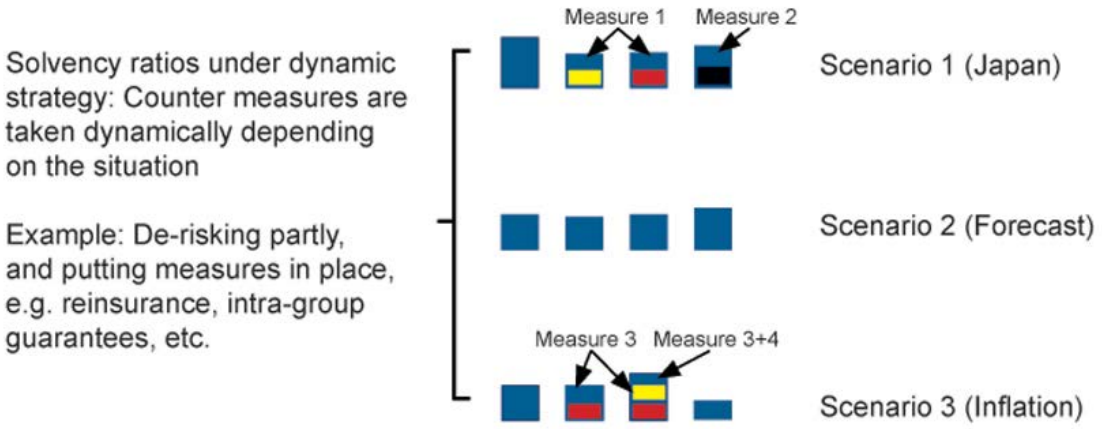
Figure 16



With such a strategy, the insurer fares well under the Japanese scenario, slightly worse under the forecast scenario, and worse again under the high-inflation scenario. However, the financial position is acceptable under all scenarios. It foregoes expected profit under the forecast, but would not face insolvency under either a high-inflation or a Japanese style scenario.

Finally, the insurer fine-tunes its strategy by also considering intra- and external-group reinsurance. By putting these additional measures in place, the solvency ratio can be improved for specific situations that would cause a short term financial strain.

Figure 17



Case study 2: Pandemic

This pandemic scenario case study illustrates some of the concepts involved in a scenario analysis, particularly concerning the extent of the assumptions included and the need for expert advice. It is not meant to serve as recommended scenarios for this kind of event.

To assess the impact of a pandemic on a firm's balance sheet, it is necessary to be clear on aspects such as:

1. Is it an influenza pandemic or a pandemic of a different type?
2. What is the severity of the pandemic considered?
3. Over what time horizon will the pandemic take place?
4. What will be the effect on insurance risk factors, e.g., mortality, morbidity, etc.?
5. What will be the effect on financial markets?
6. What will be the effectiveness of countermeasures, e.g., of health services and central bank interventions?

Once these and potentially other factors are agreed upon, the impact on the firm's financial position can be determined:

1. What will be the effect on life and health business?
2. What will be the effect on other lines of insurance business, e.g., medical expenses, business interruption, D&O claims, etc.?
3. What will be the effect on assets?

Many parameters that define a pandemic are highly conjectural. This is illustrated by the sample of possible influenza pandemic scenarios shown in the table below that have been formulated by regulators and other institutions. They have different assumptions regarding the severity of an influenza pandemic, as well as on its effect on the financial markets.

Each firm that conducts a stress test on the effect of a pandemic has to develop its own scenario assumptions.

	SST	**Singapore**		**McKibbin + Sidorenka**				**SOA**		**CBO**		**EU (based on CBO assumptions)**	
		Short Term Scenario 3a	Short Term Scenario 3b Mild		Medium	Severe	Ultra	Mild/ Moderate	Severe	Mild	Severe	Severe	Severe negative
Total deaths ('000)	40,000	20,000	40,000,000	1,440	14,400	72,000	144,000	6,688	60,800	2,000	60,000	60,000	60,000
Infection Rate	30%	30%	30%	30%	30%	30%	30%	25%	30%	25%	30%	30%	30%
Mortality Rate	1.67%	0.83%	1.67%	0.06%	0.60%	3.00%	6.00%	0.33%	2.53%	0.10%	2.50%	2.50%	2.50%
Excess Mortality	0.5%	0.25%	0.5%	0.02%	0.18%	0.90%	1.80%	0.08%	0.76%	0.03%	0.75%	0.75%	0.75%
GDP													
Equity													
FX													
Real Estate													
Spreads													
Interest Rates													

Firms need to understand the assumptions underlying a scenario assessment and consider other outcomes. But, just as making too many optimistic assumptions can lead to a false sense of security, it also has to be recognized that it easy to create an even more extreme outcome by conflating negative assumptions. The degree of speculation, of good or bad effects, needs to be understood and communicated. While the use of scenarios escapes the need for probability distributions, a sense of likelihood is still needed to convey the sense of urgency of the severity of such a scenario.

An influenza pandemic may not be the only type of pandemic to which a firm can have a high risk exposure. The firm will need to consider whether there are similar possible threats and whether an influenza epidemic is a good representative of the class of possible pandemics or more local events. For example, a sudden resistance to antibiotics would rollout in a very different manner than a flu pandemic. An influenza pandemic is characterized by a high infection rate (often assumed to be in the range of 20-30% of the population) and relatively low additional mortality. Will there be, for example, pandemics with lower incidence rates but higher mortality rates? This might lead to different effects by line of business, as well as on financial markets. It is possible that the panic during a pandemic where the incidence rate is low but the mortality of people infected is 80% or 90% will be far more profound than during an influenza pandemic, where the mortality is in the range of 1% to 3%. In considering the likelihood of such a pandemic the firm would have to recognize that for an outbreak with high mortality to spread widely it would need to have the necessary infectivity and be infective during the pre-symptom stage.

Below are three illustrative pandemic scenario narratives. The first is a standard influenza scenario with effective health service and central bank measures that limit the effect on financial markets. The second narrative is about a more severe influenza pandemic centering on Europe, with less effective responses. The third scenario is one describing an event with lower prevalence and higher mortality.

A mild influenza pandemic:

A global flu pandemic originates in Asia and then spreads to Europe and the U.S. Asia is most affected, followed by Europe and the U.S., influenced primarily by population density and the relative efficiency of health services and containment measures. As the severity of the flu pandemic becomes clear, markets become more risk averse and investors move into European and U.S. government bonds, while spreads widen and stock markets fall. The pandemic runs its course after 18 months and markets slowly stabilize, leaving 5 million dead.

Health supply chains are strained, but do not break. The relatively slow start of the pandemic allows governments to implement emergency measures in a relatively timely manner. However, services deteriorate, mostly in Asia as well as in Europe. This causes an increase in frequency and severity of fires, and particularly an increase in mortality of older persons that rely on care.

Asian markets fall most, as investors move capital to Europe and the U.S., and foreign exchange rates of Asian currencies drop markedly against the Euro and US dollar. Travel and leisure-related firms are hit hardest, while shipping and cargo flights continue but with slower

turnarounds and lower profit margins due to quarantine measures. Insurance stocks drop massively due to uncertainty regarding their exposures to pandemic claims.

Central banks act to mitigate the effects of the pandemic and try to calm the markets and to bolster public confidence. Most slash their interest rates by at least 100bp and inject liquidity into the financial system. These measures cannot wholly offset the dampening effect of the crisis on economic growth, which creates short-lived contractions in economic activity, the effect varying by country. But as the crisis passes, activity and risk appetite will recover, boosted by still-easy monetary conditions for some time.

A severe influenza pandemic

There is an initial outbreak of a flu pandemic with a medium level of additional mortality. Health services distribute flu vaccines that are moderately successful, limiting mortality to 0.5% among those infected, with an incidence rate of 25%. Subsequently the virus mutates into a more aggressive variant leading to an extremely high mortality rate of 25%, also with an incidence rate of 25% against which the vaccination is unlikely to be completely effective. This leads to widespread panic and a near collapse of the financial markets. Total deaths during the first phase are about 0.9 million, in the second phase 44 million.

The pandemic is most pronounced in Europe, where open societies and high population density make countermeasures less effective. The U.S. is able to close their borders and is less affected by the second wave than elsewhere. After the first wave, the EU prematurely declares the pandemic over, and is slow to ramp up measures when the second wave starts. In Asia, measures are more effective and outbreaks are contained. The pandemic finally runs its course after one year and financial markets slowly recover. However, the vaccination used during the first phase has led to complications in 1% of people with long term disability who will require long-term treatment. In the EU and U.S., with about 600 million people, this leads to 6 million disability cases, also causing class action suits against pharmaceutical companies.

A non-Influenza pandemic

A totally new virus combining the most damaging effects of its components, air-born hemorrhagic smallpox, has been created by a South Asian dictatorship. It is highly infectious and is being weaponized. Due to a breach in safety measures, the virus escapes and starts spreading. Lack of information and effective counter-measures cause the virus to spread rapidly, without the neighboring states being informed. After a few weeks, infections appear first in neighboring states, then globally, clustered in large cities with airports.

The specific nature of the pandemic with a relatively low infection rate (1%) but very high mortality once infected (80%) leads to widespread and extreme panic and a near complete shut-down of financial market and a severe impact on Asian economic activity.

Foreign investors and firms evacuate their staff and fly them out of Asia. This leads to a further spread of the infection. Among Western economies, Australia and Canada are most affected, followed by the U.S. and Europe, related to some extent to the number of Asian expatriates.

International travel and trade comes to a complete halt as the panic spreads. The virus is finally stopped, after a global death toll of 64 million. Of those infected and surviving, twenty percent face long-term effects due to kidney failure, resulting in numerous disability insurance claims.

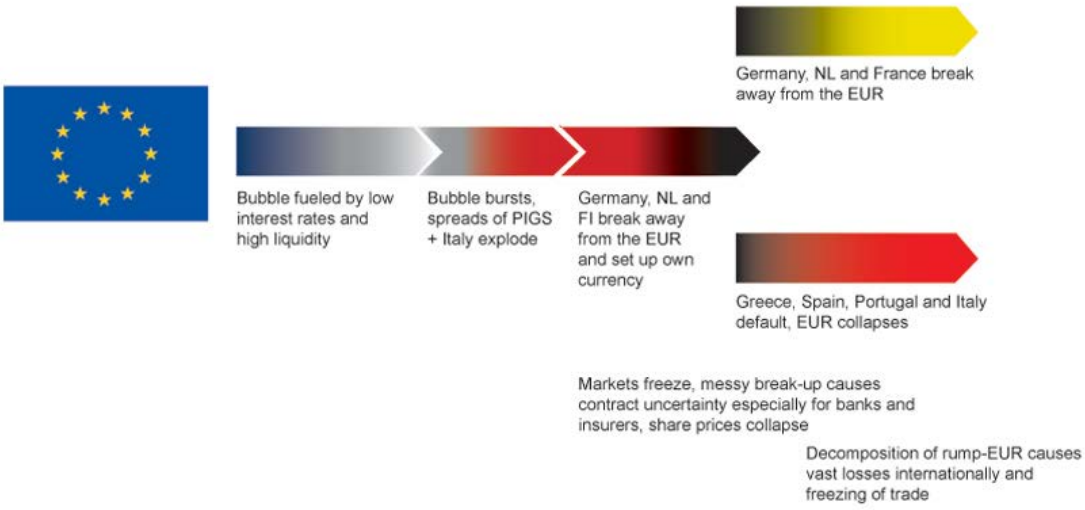
Case study 3: Sovereign default

Sovereign default is a scenario that is difficult to formulate, both from a technical point of view and for political reasons. There is a tendency to downplay its potential effects by considering only mild scenarios, since some believe that even discussion of such an event can make it more likely, by eroding market and public confidence. As an example, this case study addresses a sovereign default occurring in the Eurozone.

When formulating such a scenario, it is necessary to specify the ramification of the default in detail. For such a scenario, the sequence and time dimension is essential to gain insight into the potential exposures to the sovereign default event. For instance, the risks emanating from only a Greek default would be materially different than if Germany were to leave the Eurozone.

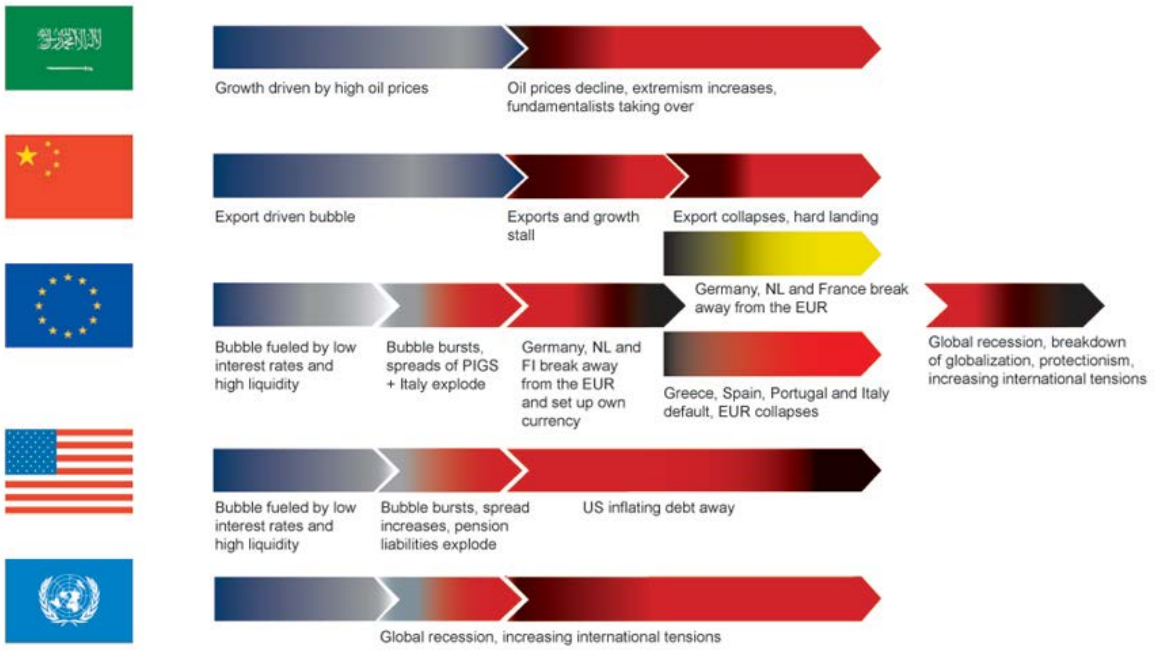
As an illustration, consider an example where Germany, the Netherlands and France leave the Eurozone. In this scenario, this development would lead to a cascade of sovereign defaults of Greece, Spain, Portugal and Italy, and ultimately to the dissolution of the Euro.

Figure 19



It is not realistic to consider such an event isolated only to the Eurozone. Such an event would have global repercussions. In a pessimistic scenario, this could lead to the U.S. inflating its debt away. Then the collapse of trade from the EU and the U.S. would lead to a hard landing of export oriented economies in Asia, resulting in a deep global recession.

Figure 20



Assumptions regarding risk free rates, spreads and foreign exchange rates of relevant currencies would be developed. Also the exposures and effect of the insurance and other financial service sectors would be assessed.

For an insurer, the effects on its operations and legal considerations would be analyzed. Questions might include:

- What would happen to contracts in EUR, when the currency doesn't exist anymore?
- What would be the situation between the time of default and when markets in the defaulting jurisdiction start working again?
- What would happen with collateral situated in defaulting currencies?
- What would be the effect on intra-group transactions / guarantees to legal entities in jurisdictions with defaulting currencies?
- What would happen to contracts with policyholders when the currency is changed?

The value of such a scenario analysis is not merely gaining insight into the potential financial loss, but also to be better able to formulate and implement countermeasures. Thinking through such an event allows management to make informed decisions, for example, on:

- Investments,
- Potential operational problems in case of a sovereign default, e.g., IT and financial reporting,
- Maximizing liquidity, e.g., by optimizing collateral and intra group transactions, and
- Improving contract certainty.

Conclusion and outlook

Scenario analysis and stress testing are emerging, powerful tools to assess a firm's and a nation's exposure to risks. These can be more than a mere complement to economic capital or solvency models, well suited to analyze the uncertain and non-quantifiable events that are most likely to surprise to both firms and regulators.

Both the process of developing scenarios and their financial effects can provide insight to the risks of a firm, and enable more appropriate risk limits, thus supporting the deeper embedding of risk management within the firm as a whole.

The financial crisis beginning in 2008 has reminded users that they can be blind to the limits of their models used to make business decisions. The crisis has also highlighted the need to have a deeper understanding of systemic risks that affect not only a small number of financial institutions and large parts of the financial market, but also how the regulatory framework itself may experience unexpected surprises. Regulators not only can supplement their risk based capital requirements with scenario analysis and stress testing, but they may also use them to enhance their own agreements with other regulators.

For instance, the Swiss Solvency Test has used scenarios since 2006 for all insurers and reinsurers in Switzerland, stress tests have been used by EIOPA to assess the resilience of large insurers, and the Federal Reserve Board has used scenarios to assess the financial state of banks. Australia used stress tests in 2004 and 2005 to assess their exposure to a housing bubble, thus avoiding much of the pain subsequently endured by other jurisdictions.

Scenario analysis and stress testing can be powerful tools for both firms and regulators. Their expanded use can enhance a multi-functional and multi-level involvement in a firm's risk management process, from the choice of conditions and events studied, to the formulation of possible scenarios, the evaluation of their effects, and the development of contingency plans and risk mitigation strategies. Similar to planning, the process used to develop and perform these analyses, underpinned by sound governance practices, can bring deeper understanding to the firm to enhance its normal business decision-making.