

<Provisional Translation of an article in the *Kinyu Zaisei Jijo* August 27, 2012 issue>

## Study of Stress Scenarios

### Why we need to consider stress scenarios -----taking JGB crisis as an example

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*One tends to avoid questions for which there are no good answers. For Japanese financial institutions, what they should do to prepare for the possible default of Japanese government bonds (JGBs) must be one such question. However, one should not avoid these uncomfortable questions, as low probability high impact risk (tail risk) tend to materialize more frequently than one might think, and the effect may manifest itself through various channels, and have important impact on corporate management. I would argue that stress scenarios, rather than mechanical stress testing, would better help firms to prepare for such contingencies. (This article was written by the author based on his speech on “Financial crisis: Stress scenario and ERM” held by the Japan Risk Forum’s executive committee on April 18, 2012.)*

#### Interest in Stress Scenarios

About a year and a half ago, my friends and I established a small study group consisting of people involved in risk management in financial institutions. Risk management in financial institutions has made enormous progress over the last decade, and highly sophisticated risk management techniques are now in common use. Yet, it has also become evident that low probability high impact events - the so called tail events - which cannot be easily handled within the standard risk management framework are critically important. How then, should corporate management evaluate and prepare for such risks? – This is the basis of which we set up this study group called the ‘Stress Scenario Study Group’ and which has now evolved to become the Japan Risk Forum..

Some of the issues that we have been discussing in this group include the risk of the breakup of the Euro, JGB default risk, as well as the risk of a mega

earthquake and geopolitical risks. The more we discuss these issues, the more we realized that there are complex and far-reaching issues involved, that management of any firm should be aware of. That is why we decided that it would be valuable to open our group and discuss the issues with a broader range of people involved in risk management, in the shape of this forum.

### Are JGBs risk-free assets?

Government bonds of advanced countries have long been considered as safe assets. However, during the Euro crisis, we came to realize that there are default risks even in advanced countries' government bonds. A possibility that most of us had never entertained became a reality. When we reflect on what this new insight means for JGBs, we realize that in terms of indicators of credit risk JGBs have far worse numbers than Greek government bonds. It would be foolhardy to ignore the default risk for JGBs.

Yet, Japanese insurance companies and other financial institutions are purchasing 30-year JGBs at a yield of 2% and do not seem particularly concerned about it. It may be hard to imagine that JGB may default, but if a default does occur, it will have enormous negative impact on Japanese financial institutions. What then, are the risk managers of these institutions thinking when they are buying JGBs at such a low yield?

Lately, I have had many opportunities to give presentations on the Japanese fiscal conditions and the Euro-zone crisis. During the session, I usually ask the audience what their views on the default risk of JGBs are. I ask the question: "When do you think JGBs may fall into a situation like the government bonds of the (European) countries currently facing sovereign credit risk?" To make it more specific, I ask the audience when they think JGBs' credit default swap (CDS) spreads will exceed 400 basis points, or an equivalent increase in the risk premium of long-term government bond will take place. I ask when they think the probability of such an event occurring will exceed one-third? (1) Within 5 years from now, (2) Between 5-10 years from now, (3) Between 10-20 years from now, or (4) More than 20 years from now or never?

I have taken a straw poll of this audience, and the rough numbers are that of the 150 or so attendees here, about 10 each selected (1) or (4), and the remainder chose (2) or (3) in roughly the same proportion. This means that the consensus view of the audience today is that there is a significant chance that Japan could fall into a situation that Italy and Spain is now encountering, in around 10 years' time. Incidentally, this result is largely in accordance with the results during my previous talks.

If this is indeed the average view of JGBs' credit risk in the financial industry, there is a huge paradox: Why does the yield curve of JGBs look like what it is today?

Currently, the yield of 10-year JGB stands at 1%, that of 20-year JGB is 1.8% and 30-year is around 2%. This means that the implied forward yield of 10-year JGB 10 to 20 years into the future is between 1.5% and 2.5%. Clearly investors do not seem to think there is default risk for JGBs. Perhaps a better way to explain the apparent contradiction is that people do envisage the existence of credit risk in an abstract way, but it does not affect their actual investment decisions and hence is not priced in the market.

Our standard risk management practices consider risk only within a limited range of possibilities where fluctuations fall within a broadly 'plausible' range. So, it may be more appropriately termed as managing profit volatility under risk. Granted, even if one tried to prepare for JGB default risk, there is not much one can do: the option of not holding JGBs does not exist, nor would it make sense, from an income perspective to buy a huge amount of CDS on JGBs to hedge the default risk. Even if one is right about the JGB credit risk in the long run, taking a contrarian position is sure to produce losses in the short run, and you would likely be bankrupt before you are proven to be correct.

So, the wise attitude would be not to ask questions for which there are no good answers, and to see how things develop without taking any specific action. To the extent that one wishes to maximize the return on capital given a certain risk profile, this is a logical behavior. Maximum loss occurs when capital is completely wiped out, so it simply does not make sense to increase capital, and hence reduce return, to prepare for low-probability extreme events where the loss could amount to multiples of capital.

### Materialization of tail risks is not as rare as one might think

It is not rare to find materializing of tail risks that enormously affect business management. Events like the March 11 earthquake, the collapse of Lehman Brothers and European debt crisis, would have been considered to be tail risks, but unfortunately such presumed tail events have become routine events of late.

Moreover, what we have learned that not only are these events not as rare as we thought, but the impact could be much larger than we imagined. The size of the regional economy that was directly hit by the Great East Japan earthquake accounted for only 2-3% of the entire Japanese economy, but because some of the factories located in the earthquake affected parts of Japan were the dominant suppliers of some critical parts in electronic and automobile industries, the damages to these factories resulted in a massive disruption of the production chain, affecting industrial activities not only in Japan but worldwide.

Similarly, the nuclear power accident that followed the earthquake forced suspension of nuclear power generators, resulting in shortage of electricity and hikes in power prices. In terms of economic costs, the secondary effects of

electricity shortage and price increases could easily exceed the direct tangible losses from the earthquake.

Spillover effects were also important in the Euro debt crisis, the Subprime Meltdown, as well as the recent floods in Thailand. In the Euro case, at first, many thought the Greek's fiscal crisis would not have a significant impact on the Euro zone as a whole because Greek's economy accounted for only 2-3% of the entire Eurozone.

In the case of the Subprime Crisis, the subprime market accounted for only 15% of the U.S. mortgage market, so that most people did not initially imagine that problems in the subprime mortgage would lead to a meltdown of the financial system worldwide.

Turning to Thailand, when the catastrophic floods occurred in the second half of 2011, many factories were submerged underwater, so that the supply-chain system was disrupted. Accordingly, the impact of the floods on production activity was much larger than the production losses in the flooded factories themselves.

Two lessons can be drawn from these recent examples. First is that it is dangerous to ignore tail risks. Second one is that spillover effects from the materialization of tail risk are complex and can have large and unexpected consequences, which could easily dwarf the losses from the event itself.

A typical stress test in a bank involves providing, say, an X% shock to stock price or long-term interest rate. Moreover, the size of the shocks tends to be that provided by the regulatory authorities rather than what the management itself considers as a prudent scenario. Of course, the stress test results do provide the management with a sense of the shocks that will have critical consequences, but the exercise does not tell us what can be done to prepare for, or mitigate the shock. The exercise could easily end up being a mechanical one without much value. In order to extract managerial lessons from such exercises, it would be useful to hypothesize series of events that may lead to such a shock in prices or interest rates, namely a stress scenario, which would also help us to think of the spillover effects.

### Scenarios for Japanese Government Debt Crisis

As an example of a stress scenario, let us take up the scenario involving a collapse in JGB prices. This would be triggered by a loss of markets' faith in JGBs for some reason. It is hard to predict in advance what would lead to the loss of faith or when it would happen, but it is not hard to predict the events that would unfold.

Once investors begin to unload JGBs and take short positions, medium- and long-term interest rates will rise sharply, triggering a vicious cycle like that

observed in the progression of the Euro debt crisis. The first negative feedback loop is that the increased interest rate raises funding costs for the government, which worsens the fiscal position, leading to an increased risk premium for JGBs and thereby further increasing the yield for JGBs. Another route is that the fall in market price of JGBs will generate large valuation losses for Japanese banks that typically hold a large amount of JGBs on their books. This leads to an increased risk of a systemic banking crisis that requires a large scale fiscal support, which in turn invokes a further rise in the sovereign risk premium and hence the bond yield.

The Japanese case will be different from the Euro zone in one important respect. If the flight from investment in JGB involves capital flight, this will trigger a sharp depreciation of the yen in the foreign exchange market. Note that by contrast, if domestic investors try to shift their investment in JGBs to other domestic (yen) assets, as the supply of these assets are fixed, this will cause these assets' prices to soar. But there are limits to how far this can happen, which also implies that the drop in JGB prices will hit a floor sooner or later, so that the threat of a extreme JGB crisis is somewhat muted.

So, the main issue is the implication of capital flight combined with a sharp depreciation of the yen. To the extent that yen depreciation increases demand through improved external competitiveness and also results in the reversal of deflationary trend through increase in import prices, we may hope for a stabilizing effect to the JGB crisis.

Nevertheless, this is not necessarily assured. If the depreciation of the yen takes place after industrial hollowing out in Japan, there is no longer manufacturing capacity to respond to the price signals from depreciation, and there will be no increase in exports. Moreover, inflation will accelerate and domestic purchasing power will decline, leading to a decline in domestic demand and a recession. The recession will aggravate Japan's fiscal balance and will result in a further loss of credibility in JGBs.

Inflation itself curtails the real value of debts (so is helpful for debt sustainability), but if the Bank of Japan (BOJ) increases its policy rates to counter inflation and the depreciation of the yen, the short-term JGB yields will soar and fiscal condition will be further exacerbated. Capital flight will accelerate, the yen will collapse, and hyperinflation and sovereign debt default may follow.

#### Alternative scenario: capital control with moderate inflation

This scenario that we have described above is not totally convincing in that it assumes that the BOJ will hike its interest rate in response to accelerated inflation and capital flight. If the BOJ is solely committed to price stability, then BOJ may increase rates, but given what this would entail for the broader economy, it would be more realistic to think that the BOJ will maintain the low

interest rate level to avoid a fiscal crisis.

In that case, the yields of short-term JGBs will remain low so that the national debt need not snowball quickly due to high interest burden. The problem is that this strategy would probably accelerate inflation as well as depreciation of the yen, and lead to further capital flight.

This means that severe capital account regulation will have to be imposed to prevent capital flight. In this sense it may be said that it is fortunate that the current Foreign Exchange Law contains an open-ended provision to allow the imposition of capital controls in emergency situations, as necessary. By containing the funds inside its borders and combining low-interest rates with higher inflation, Japan will be able to gradually reduce the real value of the debt.

In the seminal book “This Time Is Different”, the authors Carmen Reinhart and Ken Rogoff point out that debt problems have historically been solved by “financial repression”, namely a combination of policies whereby low interest rates are maintained and domestic investors are effectively forced to hold government bonds.

After the World War II, Japan solved the problem of massive government indebtedness through hyperinflation and the introduction of a new currency. By contrast, Britain managed to cut its debt-to-GDP ratio which immediately after the war had reached 240 percent, while avoiding hyperinflation. This was achieved by expanding the size of its economy in the context of the post-war recovery, fiscal support through the Marshall Plan, and maintaining a moderate inflation level while keeping interest rates low.

Inflation not only reduce the stock of real government debt, but can also help to improve the fiscal balance, if the government can curb the growth of nominal pension benefits and other expenditures below the rate of inflation, this will help the fiscal balance, as tax revenues tend to outpace the growth in nominal national income. With such a scenario, Japan will be able to avoid hyperinflation that some critics anticipate, while restoring debt sustainability. It must be cautioned, however, that if the Japanese people demand pay rises and pension increases that compensates for inflation, this scenario will not work out.

These considerations underscore the important point that stress scenarios should not be assumed to play out mechanically and deterministically, but that events will unfold as a result of interaction between government and private sector actions. In order to prepare for contingencies, it is thus important to develop several alternative scenarios and the required responses. This will allow us to judge which scenario is closest to the actual unfolding of events, where there are differences from the prepared scenarios, and what needs to be done and how planned responses need to be adjusted, without panicking at unexpected developments.

## Preparing for macroeconomic and financial risk

The probabilistic profile of macroeconomic and financial risk and natural disaster risk differ. A massive natural disaster event may occur once in several decades, but the occurrence would be random, typically following an exponential distribution. We can estimate the expected probability of an occurrence, but the event itself would be very much a random event whose timing of occurrence cannot be predicted. This means that we can only estimate the average frequency and the size of such events.

By contrast, macroeconomic and financial risk events are those where the crisis probability may be estimated; the problem is rather that the risks are mispriced. Moreover, such risks tend to accumulate gradually over time.

In the case of Euro crisis, it would have been difficult in 2006 or 2007 to forecast the eruption of the Euro crisis. Having said so, the Euro crisis was not totally unpredictable. A lawyer, Geffery Theils, wrote an article titled "Thinking the Unthinkable" in 1998. He wrote about how to break up the Euro area from the legal point of view, in the event that the Euro could not be sustained. In 2005, he wrote another paper in 2005, titled "Not so unthinkable". His most recent thesis written in 2010 was titled "Thinking the Probable". We can tell that people did recognize the increasing possibility of a Euro crisis and its breakup.

Many attribute the cause of the Greek government-debt crisis to the disclosure in September 2010 by the new Greek administration of the past cover-up of fiscal deficits. However, the problems did not emerge suddenly. The point is that people underestimated the extent of risk accumulation, so that they failed to change in a timely manner their recognition of the situation from "unthinkable" to "thinkable". A similar delay in recognition was evident with the subprime mortgage crisis, but there were differences at the individual institution level. As the Citibank Chairman Chuck Prince famously said, many financial institutions "danced (maintained subprime position)" until the very last minute, but there were other that stopped "dancing" and curtailed their positions before the outbreak of the Subprime mortgage crisis.

The important thing is how to feed risk information to corporate management in an appropriate fashion. Theoretically speaking, it should be easier to revise the assessment of macroeconomic and financial risk than to revise that of earthquake risk for a nuclear power plant. Having said so, the difference in risk assessment between yesterday and today is marginal, making it difficult to decide when to downgrade your risk assessment. In other words, it is like a situation of the proverbial frog in water being brought to boil. It is said that a frog, when placed in water that is gradually heated, cannot feel the difference and ends up being boiled alive. To the frog's credit, I should mention that this is apparently a myth, and the frog will actually jump out of the water when the water reaches a certain temperature. So, we must emulate the actual frog rather than that in the proverb.

The important thing is to assess the accumulation of risk and make timely decisions to act. To do so, rather than a simple stress test involving, say, a hike in interest rate, we should examine various stress scenarios to find out what the critical elements are, what kind of responses we should take, and when we should take such responses. Conducting such exercises in advance should benefit risk management.

Generally speaking, a company that has large and well-organized risk management division tends to be bureaucratic in its decision making. In a bureaucratic organization, it is difficult for a subordinate to raise an issue to his/her boss without preparing an answer to how the issue may be addressed. It is only the top management that can comfortably raise difficult and open-ended issues, and therefore it is the prerogative of management to raise difficult questions. Having said so, we should not rely on the management as an individual to come up with the necessary questions. We need to go beyond this and establish a system whereby the top management requires stress scenarios to be developed, which are discussed systematically for the management to decide on needed actions.

#### Mr. Ariyoshi's biography

1976 Received Bachelor of Engineering from Tokyo University (Department of Technology)

1976 Joined the Ministry of Finance (MOF)

1981 Received Ph.D. in economics from the University of Oxford

1996 Director of the Research Office, Securities Bureau, MOF

1998 Assistant Director, Monetary and Exchange Affairs Department, IMF

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