

## Masaaki Shirakawa: How to address tail risks

Speech by Mr Masaaki Shirakawa, Governor of the Bank of Japan, at the Annual General Meeting 2011 of the Foreign Bankers' Association in the Netherlands, Amsterdam, 27 June 2011.

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### I. Introduction

Today I am privileged to have the opportunity to speak before the Foreign Bankers' Association in the Netherlands, a respected association with a rich history and tradition. I would like to express my gratitude to Chairman Freddy Boom for the warm introduction. Since I believe this marks the first time for a governor of Japan's central bank to address the association, let me begin my remarks by briefly reviewing the historical relationships between the Netherlands and Japan. As many of you may know, the two countries have nurtured close ties for centuries. The first contact between them dates back to 1600, when a Dutch trading ship named *De Liefde* drifted to the land called *Bungo*. I happened to have worked at our branch located near the point of landing and have long been interested in this episode. A Dutch national named Jan Joosten became a diplomatic adviser to the first Shogun of the Tokugawa government, which maintained a national isolation policy for some two hundred years from the early 17th century to the mid-19th century. Nevertheless, as an exception, the Netherlands continued to be a trading partner with Japan during this period. For Japan, the Netherlands was not merely a provider of foreign merchandise but also a window on advanced western science and technology, such as medical science, physics, and chemistry. The intellectual class in Japan referred to such subjects as *rangaku*, or "Dutch studies." Let me also note that the Enlightenment thinker Yukichi Fukuzawa, whose portrait is on the ten thousand yen bill, made strenuous efforts in his younger days to master Dutch and learned about western civilization from Dutch literature.

When I was given this chance to make remarks in the Netherlands, the first thing that came to my mind was the fact that both the Netherlands and Japan have devoted significant energy to dealing with the war against nature. With a quarter of its land below sea level, the Netherlands is well known for its history of repeated hardships caused by great floods. Historically, Japan has lived with earthquakes. Floods and earthquakes do not happen frequently but do cause significant damage when they occur. In this regard, within the short period of the past three years, Japan experienced not only the recent Great East Japan Earthquake but also another significant event. Needless to say, this was the global financial crisis, or the Lehman shock. The two differ from each other in that one was an economic shock and the other a natural disaster, but they share a common feature in that both have had enormous impact on the economy and society. How to address such events is definitely a big challenge for the authorities in many countries and for the management of financial institutions including the members of this association.

When describing these events, we often use the term "tail events" (Slide 1) and refer to risks arising from such events as "tail risks" (Slide 2). The word "tail" implies that such events rarely happen and rest within the tail of a probability distribution. To be more precise, tail events or tail risks involve two types of events. One would be along the lines of the recent earthquake in Japan. This had a magnitude of 9.0, and was followed by an enormous tsunami that hit a wide area of east coast of Japan. The last time in recorded history that a comparably sized tsunami hit eastern Japan was in the year 869. This type of event is therefore extremely rare and rests far beyond the end of the tail (Slide 3). Another type of tail event is a financial shock, like the Lehman shock. The financial crisis with the most comparable seriousness and geographical scale as the Lehman shock was the Great Depression of the 1930s. Such events therefore occur with low probability but not as rarely as once in a thousand years. Looking back at the past twenty years, however, financial

crises have occurred more frequently than would be assumed in a normal probability distribution. In any case, both types of tail events have a devastating impact on the financial markets, the economy, and society (Slides 4, 5, and 6).

In cases where extremely rare events far beyond the end of the tail occur and where rare events within the tail happen more frequently than anticipated, the common feature is that such unanticipated events invite devastating turmoil. The global financial crisis triggered by the subprime loan problem in 2007 was attributable to the formation and bursting of the credit bubble at a scale that had not been anticipated in the preceding period. Natural disasters such as earthquakes, tsunami, hurricanes, and floods as well as diseases including the pandemics of highly virulent new types of influenza could develop into tail events once their magnitude and the scope of damage surpass expectations. The same could be said for large-scale computer disruptions, acts of terrorism, and wars. Responses to risks related to tail events are important not only as part of national economic policy but also in terms of management of the financial institutions for which many of today's participants are responsible.

Today, I will talk about how to address tail risks while focusing on the recent financial crisis and the March 11 earthquake in Japan.

## **II. The great east Japan earthquake**

### ***The damage***

With regard to significant tail events that have materialized in recent years, many that are related to the global financial crisis have already been discussed. Therefore, I would like to share with you some factual information about what exactly happened following the Great East Japan Earthquake.

This time Japan suffered the interrelated tragic events of an earthquake, a tsunami, and an accident at a nuclear power plant. The toll of dead and missing persons was less than the 105 thousand recorded at the time of the Great Kanto Earthquake of 1923 but still reached nearly 23 thousand. The amount of damage to capital stock from the recent earthquake has been placed at about 3 to 5 percent of Japan's GDP, according to government estimates (Slide 7). In the disaster areas, the infrastructures of electricity, gas, water, and communications services were interrupted across a wide area. Transportation networks such as roads, railways, and ports became dysfunctional all at once. To make matters worse, a serious fuel supply shortage followed due to problems at oil refineries and the disruption of transportation services. The tsunami seriously damaged the nuclear power plant, causing an electric power shortage problem. Most of the key infrastructures and fuel supplies have already been restored in disaster areas. But the situation at the nuclear power plant has not yet reached the stable stage of a cold shutdown. The estimated amount of damage I have just mentioned covers only capital stock and does not include damage to human resources or the economic impact of the nuclear power plant accident. Overall, this was truly the materialization of tail risk.

### ***The effects on economic activity***

I will now briefly describe the impact of the earthquake on Japan's economy, focusing on the points relevant to considering how we should address tail events.

First, needless to say, production has declined sharply and significantly (Slide 8). Although the March 11 earthquake clearly had no impact on the initial ten days of the month, a reading for the industrial production index in March showed that this fell by 16 percent on a month-to-month basis, the largest one-month decline on record. This is attributable to the devastating damage to the production facilities in the disaster areas as well as electricity supply constraints and supply-chain disruptions experienced across wider areas. The pronounced

production decline led to an export decline. As a result of the production decline, exports registered an almost 15 percent cumulative drop from February in the subsequent two months combined.

Second, the earthquake also affected the sentiment of economic entities. Private consumption declined as voluntary restraint by consumers dampened spending, particularly for services such as tourism and eating out. Moreover, the impact of the disaster went beyond just the sentiment of the Japanese people to affect the global perception of Japan being safe and secure. Although the current radiation levels in Tokyo are roughly the same as in Amsterdam, Berlin, or Paris, the number of visitors from abroad for business purposes or as tourists fell sharply below the level registered a year before, declining by 50 to 60 percent after the recent earthquake (Slide 9).

Third, despite such a sharp and significant drop in production, the economy is returning to a gradual recovery path with the easing of the supply-side constraints. The current downward pressure on the economy following the disaster is basically arising from the abrupt supply-side shock. The fundamental conditions for growth – namely, expansion of overseas economies – remain intact. In this regard, the current situation differs from the period following the Lehman shock when demand evaporated both at home and abroad due to financial contraction. In fact, the restoration of supply-chain disruptions has been making steady progress, thanks to strenuous efforts by private firms. Regarding the electric power shortage problem, although uncertainty and concerns remain in the medium and long run depending on the outcome of the ongoing discussion about future nuclear power policy, we are seeing better prospects for surviving the summer, when demand peaks due to the use of air conditioners. We have seen more thermal power plants resume operations, more firms install in-house power generation facilities, and firms and households make various efforts to conserve electricity. Manufacturing production is gradually recovering from the bottom in March and is expected to be restored to the pre-disaster level sometime in the third quarter of this year.

Fourth, with regard to the global implications of the recent earthquake, its negative impact spread to overseas economies through supply chains with a certain time lag. Production in the auto and electronic products industries dropped in Europe, the United States, and Asia (Slide 10).

### ***The impact of supply-chain disruptions***

As I will explain shortly, the recent earthquake taught us various lessons. In terms of how to address tail events, the following facts require special attention.

First, I would draw attention to the importance of supply-chain disruptions. More specifically, the magnitude of the economic downturn was much larger than implied by the share of disaster areas in terms of economic size and population (Slide 11). The share of disaster areas was 6 percent in terms of GDP and 7 percent in terms of population. As I have said, however, the rate of decline in production was as high as 16 percent. The negative impact was amplified by the supply-chain disruptions. In disaster areas, there are many firms producing hard-to-replace parts for automobiles and electronics, including a producer of microcontrollers for automobiles with a global share of 40 percent. As automakers have relied on highly customized parts, a stoppage of production in disaster areas significantly affected production in other areas, including overseas firms dependent on imported parts from Japan. The significance of the impact of such complicated supply chains had not been fully recognized before the recent earthquake.

There are two important reasons for the greater-than-expected impact of the recent supply-chain disruptions. The first is the low level of parts inventory. In normal times, a lower level of inventory contributes to increased efficiency and higher profits. Once hit by an enormous shock, however, firms are forced to curtail production sharply within a short period of time, and this creates a chain reaction to other firms. The second reason is the concentration risk

in procurement. Tracing back to the most upstream stage of the complicated supply-chain network, it turned out that procurement greatly relied on specific firms in specific areas. As a result, the termination of production at a certain firm had a serious impact on the production activity of many firms, including those abroad. While supply chains increase production efficiency, our experience of the recent earthquake called attention to the problem of concentration risk in inventory management and procurement for the purpose of strengthening resiliency against shocks.

### ***The importance of maintaining stability in the financial system***

Now I would like to call your attention to the second factual observation deemed crucial when considering how to address tail events. This is the importance of maintaining stability in the financial system. Production started to recover from a plunge caused by the earthquake at a relatively fast pace, which is in a stark contrast to the situation in the period following the Lehman shock. One of the reasons for this early recovery is the fact that stability has been maintained in financial markets and the financial system. Both private financial institutions and the Bank of Japan have been doing their utmost to preserve stability on the financial front since immediately after the earthquake.

In terms of payment and settlement systems, although some clearing houses in the quake-stricken areas had to suspend their operations, major payment and settlement systems including the BOJ-NET – the settlement system for funds and government bonds – continued to operate smoothly. The buildings that store the computer center for the main payment and settlement systems sufficiently proved their resilience to the magnitude 5-plus earthquake in the Metropolitan Tokyo area. Moreover, at the time of the rolling blackouts that were temporarily implemented with a short notice soon after the earthquake, financial institutions' branch networks and computer centers maintained their operations by resorting to backup measures such as the use of in-house power generation facilities. Over a period of successive days following the earthquake, the Bank of Japan provided financial markets with ample liquidity that significantly exceeded the amount provided at the time of the Lehman shock. Furthermore, on the first business day after the earthquake, the Bank decided to expand the size of its program to purchase risk assets including commercial paper (CP), corporate bonds, exchange-traded funds (ETFs), and Japanese real estate investment trusts (J-REITs). This decision was made in a forward-looking manner to prevent any deterioration in business sentiment and heightening of risk aversion in financial markets from adversely affecting economic activity. If the financial system had lost its stability this time, the extent of the economic downturn would have been much larger. Therefore, it is quite important to secure stability in the financial system.

Although we have managed to maintain overall financial stability, as I have just described, we have also learned some lessons.

First, a combination of various factors could lead to unexpected trouble. In disaster areas, key social infrastructures such as electricity, gas, communications, and transportation services simultaneously stopped functioning. Although the offices of financial institutions were equipped with in-house power generators to cope with blackouts, the sustainability of such backup measures was threatened as disruptions to transportation made it difficult to procure fuel. Disruptions to transportation and associated fuel shortages also made the delivery of cash difficult.

Second, various rumors spread after the earthquake. For instance, when the yen appreciated sharply immediately following the earthquake, there was a baseless rumor that Japanese insurance companies would sell foreign currency assets due to an increase in insurance claim payments. However, these companies actually had no need to conduct such sales in order to make the payments, as they held a considerable amount of liquid assets in yen. In the week after the earthquake, rumors had spread among some foreign financial institutions that the Tokyo financial market would close. To our surprise, there was also a groundless

rumor that the Bank of Japan was planning to resort to a backup computer center in Osaka, which is located more than 500 kilometers away from Tokyo. Clearly, extreme anxiety in itself can proliferate sensitive market reactions.

### **III. Addressing tail risks: measures by financial institutions**

While specific measures to address tails risks differ depending on the pertinent risk factors, conceptually, they could be categorized into ex-ante and ex-post efforts. Before tail events take place, efforts should be made to measure tail risks as accurately as possible to make the internalization of expected losses possible and take actions accordingly. If tail risks unfortunately materialize, efforts should be made to prevent the impact of tail events from spreading. Such ex-ante and ex-post efforts should be made by individual financial institutions and firms as well as by the government and the central bank. Needless to say, there are no perfect solutions to the conundrum of addressing tail risks. At the same time, however, we are not allowed the luxury of being fatalists. We must keep thinking about how to make things better.

#### ***Holding sufficient amount of capital and liquidity***

Let me start with ex-ante measures by financial institutions to address tail risks. As completely avoiding tail events is not possible, it is indispensable to secure resiliency against shocks, namely a sufficient amount of capital and liquidity. Firms that are part of supply chains consider how much inventory they should retain by striking a balance between efficiency in normal times and stability in an emergency. In other words, the balance between “just in time” and “just in case.” Financial institutions also face an issue of a similar nature. They are confronted by the difficult question of choosing the right balance between efficiency and stability. The starting point for making a proper judgment is to grasp the significance of tail risks to which they are exposed. Given that tail events occur with very little probability but entail gigantic losses once they occur, it is extremely difficult to quantify potential losses using statistical methods. In addition, as was the case both with the global financial crisis and the supply-chain disruptions, losses from tail risks could change significantly depending on how the concerned parties respond to the initial shock; for example, in terms of whether a central bank appropriately plays the role as a lender of last resort. The widely used Value-at-Risk (VaR) model is useful for managing risks but its shortcomings should also be properly recognized. The VaR model has certain limitations in capturing tail risks because it assumes a specific probability distribution and relies on data about past events. Moreover, even when the VaR model shows that there is a 0.1 percent probability of realizing a certain amount of losses, it tells nothing about the more detailed probability distribution of losses within the realm of 0.1 percent probability.

Given such constraints, in order to capture the impact of tail risks consistent with a unique risk profile of individual financial institutions, it is useful to conduct a stress test based on various risk scenarios instead of solely relying on risk measurement techniques based on assumed probability. Taking the example of an earthquake, financial institutions’ stress scenarios could include the loss of business function in some branches, widespread credit default, and the collapse of market functioning. In the process of constructing stress scenarios and assessing the results of a stress test, the active involvement of management is indispensable. For private financial institutions, the extent to which they should prepare for tail events is a crucial management decision that will affect their capital plans and investment in key infrastructures.

#### ***Avoiding the concentration of risk exposures***

Second, financial institutions need to make efforts to avoid concentration of risk exposures. Similar to the problem of concentration risk in supply chains I mentioned earlier, in the

context of financial institutions, the concentration of credit risk and liquidity risk has particular importance. Of course, prudent financial institutions do not intentionally concentrate risk. What is worrisome is the situation where financial institutions concentrate risks without knowing they have actually done so. The subprime loans and related securitized products in the United States were believed to be safe, protected by sufficient risk diversification. With respect to mortgage loans, risk was geographically well diversified based on the assumption that housing prices would not fall on a national scale. Also, in Japan, the myth that land prices would never fall was widely believed during the bubble period in the late 1980s.

### ***Stable business continuity***

Third, on the operational front, financial institutions need to make sufficient preparations for possible physical damage, including that caused by natural disasters. In other words, preparations are required to ensure stable business continuity. To strengthen the resiliency of a business continuity plan, it is desirable not to rely solely on the first line of defense, but rather to have multilayered safety measures. For example, it is not enough to simply secure the sufficient strength of major buildings such as a headquarters and a computer center, nor is it enough to just have backup facilities. You also need to have in-house power generators to prepare for blackouts and always maintain a sufficient amount of fuel for them. When diversifying risks, it is important to check the extent of concentration risk on the operational front by giving consideration to changes in the environment surrounding financial institutions; for example, proliferation in the scope of financial business and leanings toward business outsourcing. Based on a thorough examination, financial institutions should take necessary measures to avoid concentration risk of business operations by diversifying essential facilities and functions geographically, securing alternative energy sources, and maintaining multiple counterparties for business outsourcing.

Furthermore, of crucial importance to business continuity at a time of crisis are measures to strengthen the human infrastructure by regularly reviewing the effectiveness of the existing business continuity plan and providing staff with sufficient training. The other day I had a chance to read a magazine article on an interview with the Dutch Ambassador to Japan, and was impressed by how calmly the Dutch Embassy had responded to the recent earthquake. I learned that the Embassy had conducted training under the guidance of a crisis management consultant in November last year. The training was quite detailed and covered how to evacuate, how to communicate with concerned parties, how to check the safety of Dutch nationals living in Japan, and how to respond to media inquiries. This is exactly what the famous slogan “Be Prepared” tells us to do.

### ***Global risk sharing***

Fourth, it is important to make efforts to share risk, especially on a global scale. We are not able to avoid the materialization of the risk of natural disasters. However, it is possible to mitigate casualties and losses to some extent by signing in advance a contingent loss-sharing contract between insurance companies and investors. In the case of the Great East Japan Earthquake, physical and human losses were covered not only by Japanese insurance companies but also reinsurance companies abroad. Moreover, as significant natural disasters occurred one after another recently, we have seen an increase in the issuance of catastrophe bonds as a means of diversifying the risks. Needless to say, to make such risk transfer effective, it is necessary to further promote the sound development of markets for products with a risk transfer function.

### ***Calm and orderly response***

I have discussed ex-ante measures to address tail risks by financial institutions. How about ex-post measures? In this regard, there is not much I can offer in terms of generalities. The most important thing is to effect a calm and orderly response. Coming back to the interview

with the Dutch Ambassador to Japan, the article reported that he was surprised by the fact that the earthquake did not cause panic among the Japanese people. Although I cannot make an objective assessment of the calmness exhibited by my fellow Japanese people, I can say that being calm is crucial to preventing the proliferation of damage caused by an initial shock. Another important factor is cooperation within the private sector. As I have mentioned, the restoration of supply chains has been making swift progress. Looking at worksites in the manufacturing industry, various efforts and attempts involved putting aside the usual rivalries; for example, firms in the same industry temporarily covered the production of disaster-stricken rivals and several manufacturers of final products cooperated in terms of sending staff to parts manufacturers to support their restoration efforts. Private financial institutions cooperated in various ways. For example, to help people who evacuated to places somewhat distant from the disaster areas, financial institutions in the non-affected areas allowed for the withdrawal of deposits at affected financial institutions through a simplified procedure. In the face of fuel shortages, neighboring financial institutions jointly operated cash delivery cars together, so as not to interrupt cash delivery.

#### **IV. Addressing tail risks: measures by the authorities**

Next I would like to consider the case of the authorities, especially the central bank as well as the regulatory and supervisory authorities. To address tail risks, while appropriate efforts by individual private business firms and financial institutions are undoubtedly necessary, the role of the authorities is also crucial.

First, the involvement of the authorities is indispensable because addressing tail risks entails significant costs and placing all of the burden on the private sector could hamper economic growth. This is especially the case when dealing with catastrophic natural disasters. The second reason why public sector involvement is required relates to the concentration of risk. When completely relying on market competition in the private sector, it is difficult to expect the complete internalization of extreme tail risk. In that situation, some kind of public sector involvement is necessary. Even in that case, however, if the authorities make a commitment in advance or are perceived as making an advance commitment, the private sector would stop making efforts to address tail risks. This is a typical moral hazard problem. It is difficult to set concrete criteria with regard to how much the private sector should shoulder the burden and to what extent the authorities should intervene as a last resort. In any case, to address tail risks, it is very important to properly design and put in place a society-wide risk management framework.

##### ***Resilient payment systems***

In this regard, I would like to highlight the importance of building resilient payment systems with the cooperation of private financial institutions and central banks. Major payment systems should be designed to have sufficient resiliency against tail events including natural disasters. Taking the example of the BOJ-NET, the large-value settlement system for funds and government bonds, the main computer center is proud of its strong resistance to earthquakes and a backup center is located in Osaka. At the same time, on the operational side, in order to lessen payment risk at a time of crisis, major payment systems need to adopt safe settlement features such as Real Time Gross Settlement, Delivery-versus-Payment, and Payment-versus-Payment.

##### ***Financial regulation and supervision***

Second, financial regulation and supervision is an important component of a society-wide risk management framework. In the wake of the Lehman shock and with the aim of preventing another financial crisis, an agreement was reached on the Basel III framework, which includes a higher capital requirement, a strengthening of liquidity regulation, and the

introduction of regulation on leveraging. The new framework requires the internalization of tail risks by financial institutions and provides the institutions with more incentives to lessen risks. In this context, there are discussions about the issue of “too big to fail.” These cover additional loss absorption capacity to reduce the likelihood of the failure of global SIFIs, or Systemically Important Financial Institutions, and measures to remove obstacles to the resolvability of global SIFIs, which would enable orderly restructuring and resolution. These measures aim at controlling the negative externality of global SIFIs. When designing the overall framework, it is important to choose a balance between those measures to promote the internalization of risks, such as additional loss absorption capacity, and those measures to lessen the externality itself, such as improving resolvability.

### ***Appropriately conducting monetary policy***

Third, I would like to discuss the appropriate conduct of monetary policy. Before the Lehman shock, the prevailing view among academics and the authorities was that aggressive easing after the bursting of bubbles could prevent a serious economic downturn. I myself had felt uncomfortable with such a view based on my experience following the bursting of bubbles in Japan. In the end, the Lehman shock crushed this optimistic view.

One important issue is the possibility that an accommodative monetary policy itself might heighten tail risks endogenously. In the process of lowering interest rates, financial institutions and institutional investors enjoy an increase in profits due to capital gains, as well as widened yield spreads between short-term and long-term interest rates. However, if a low interest rate environment continues for a long time, financial institutions and institutional investors can no longer enjoy such a profit increase because of narrower credit and yield spreads. As a result, they tend to bet on further declines in long-term interest rates or further squeezes in credit spreads, and attempts to profit from leveraging become more evident. In other words, financial institutions start to pursue profits by bearing the cost of tail risks by themselves. One of the factors supporting such actions is the perception that a low interest rate environment will be maintained and a situation of abundant liquidity will continue. In retrospect, during the periods of credit bubbles preceding financial crises, various financial imbalances were widely observed in the economy, such as asset price inflation, credit expansion, increasing leveraging, and a widening of term mismatch. A low interest rate environment is not the sole cause of these phenomena. But it is also true that these could not take place without the expectation that a low interest rate environment would continue for long time. The goal of monetary policy is to achieve sustainable growth with price stability. But if a central bank maintains a low interest rate environment with too much focus on the near-term inflation outlook, this could consequently encourage the formation of financial bubbles. In that sense, a central bank should pursue price stability through the conduct of monetary policy with a sufficiently long time horizon.

### ***Macroprudential perspective***

Fourth, I would like to highlight the importance of a macroprudential perspective. Maintaining the soundness of individual financial institutions is important but not sufficient to secure the stability of the financial system. For example, the global financial crisis underlined the need to enhance the cross-sectional assessment of risk concentration in the financial system. This is very similar to the case of supply-chain disruptions in which efficient supply-chain management from the perspective of individual firms did not guarantee the risk management of the economy as a whole. As these examples demonstrate, a risk assessment from a macro perspective is very important. Someone has to present analysis from such a perspective, which I call a macroprudential perspective. In this regard, central banks use their unique institutional culture of looking at the system as a whole when analyzing the economy and financial markets through the conduct of monetary policy and various operations. In fact, many central banks including De Nederlandsche Bank and the Bank of Japan have made their macroprudential assessment public and have devoted significant

resources to assessment of the risk within the financial system as a whole. I am aware that such analysis alone cannot effect the internalization of tail risks. But I expect that it could help many economic entities to recognize tail risks.

### ***Lender of last resort***

Fifth, I would like to touch upon the lender of last resort function of a central bank, which is related to ex-post measures to address tail risks. Once tail risks materialize, it is extremely important to secure stability in the financial system in order to avoid systemic risk. In this regard, central banks are required to act properly as a lender of last resort through fund provisioning and market operations. This is exactly what the Bank of Japan did after the earthquake.

### ***Effective communication***

Sixth, as an ex-post measure, effective communication is essential. As we experienced after the recent earthquake, groundless rumors often spread at the time of tail events. To make matters worse, in the absence of accurate information, economic entities tend to become too cautious. Therefore, it is essential for the government and the central bank to provide effective communication so that the public understands what is happening as well as the basic principles of the authorities' response to the ongoing events.

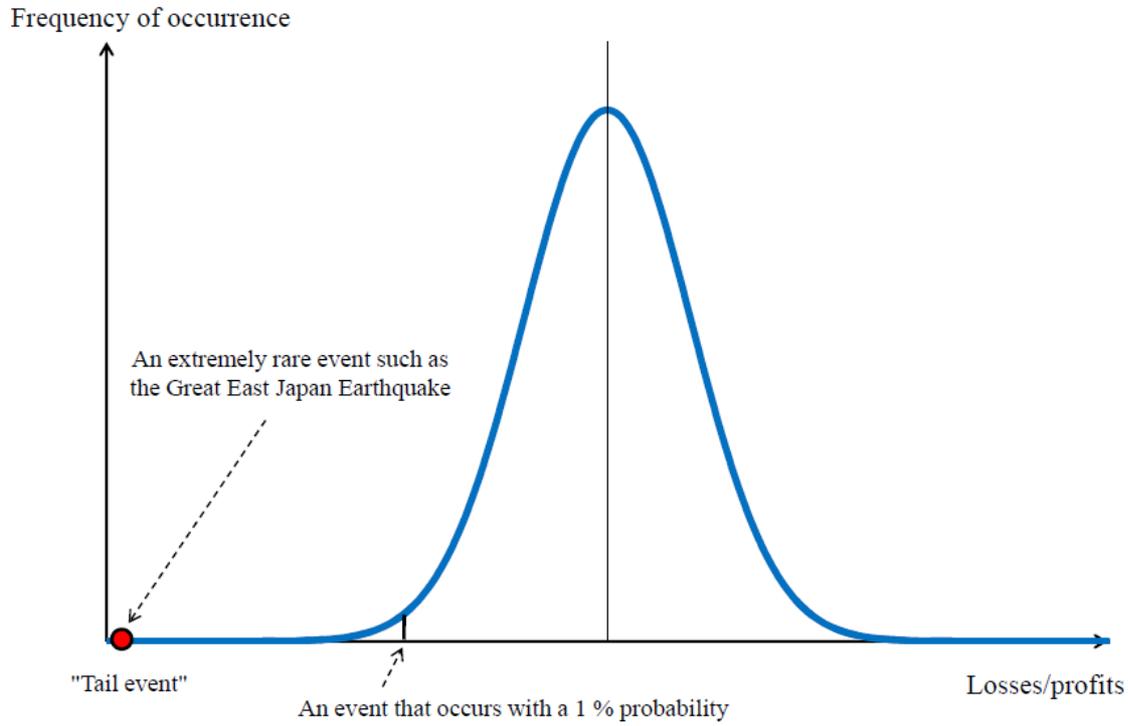
## **V. Concluding remarks**

Today I have shared with you my own thinking on the challenging topic of addressing tail risks, drawing lessons from the Lehman shock and the Great East Japan Earthquake. Specific causes of tail events have differed according to country and timing. In that sense, we should always be humble by recognizing that our knowledge with regard to tail risks is limited. It is not my intention, however, to finish my remarks on tail risks in a pessimistic tone. The materialization of tail risks itself is unfortunate but people are learning from such events. Currently, various discussions are taking place to review financial regulation and supervision, monetary policy conduct, and macroprudential measures. These efforts will certainly bear fruit in the future. Such a learning process is ongoing not only in terms of policy making but also in terms of operations at worksites. In the case of the Bank of Japan, our experience of a serious financial crisis in the late 1990s has created an institutional memory and the Bank staff have acquired know-how. The specific impacts of earthquakes and financial crises differ but they have something in common. As crises always arrive in a different guise, the role that humans play is very important. In this sense, it is crucial to promote cooperation among private financial institutions, between the authorities and private financial institutions, and among authorities all over the world. I look forward to exchanging views with participants today in the following Q&A session.

Thank you for your kind attention.

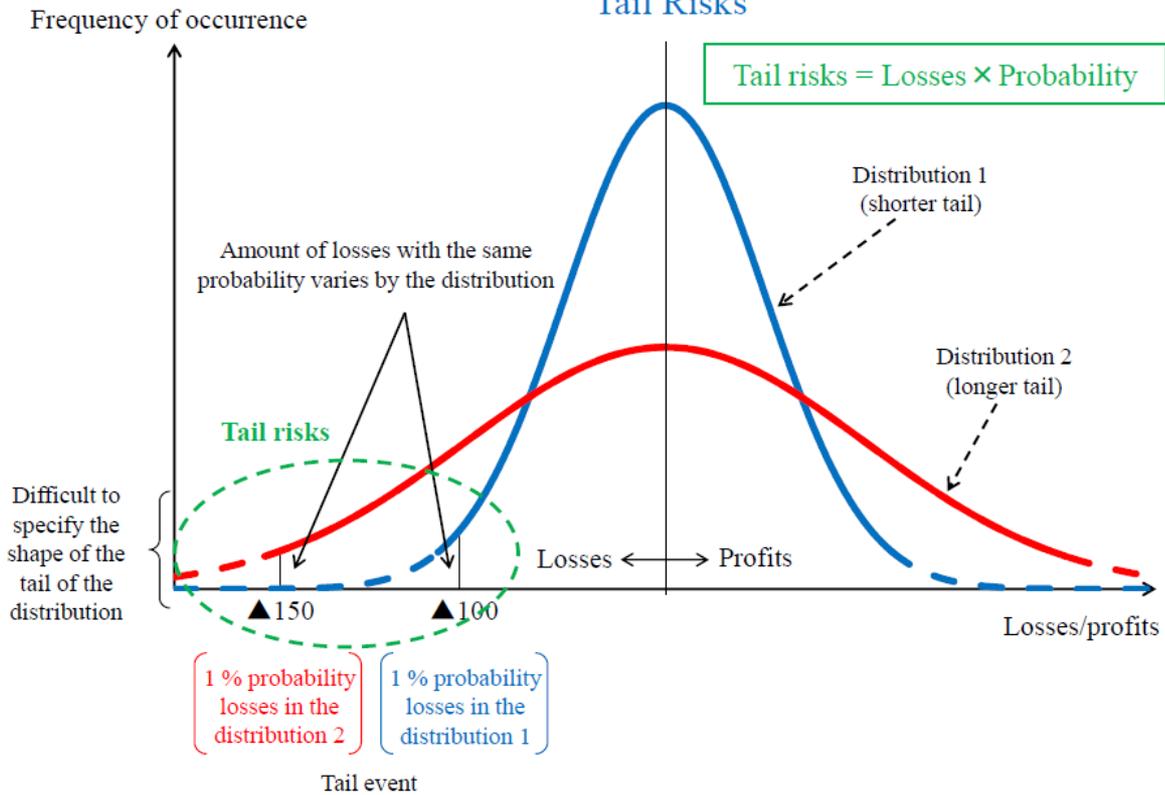
Slide 1

### Tail Events

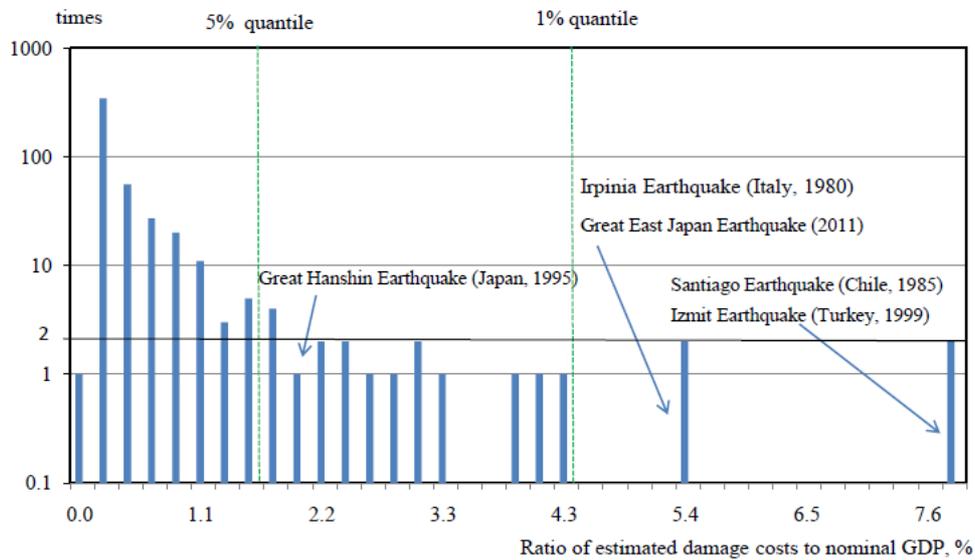


Slide 2

### Tail Risks

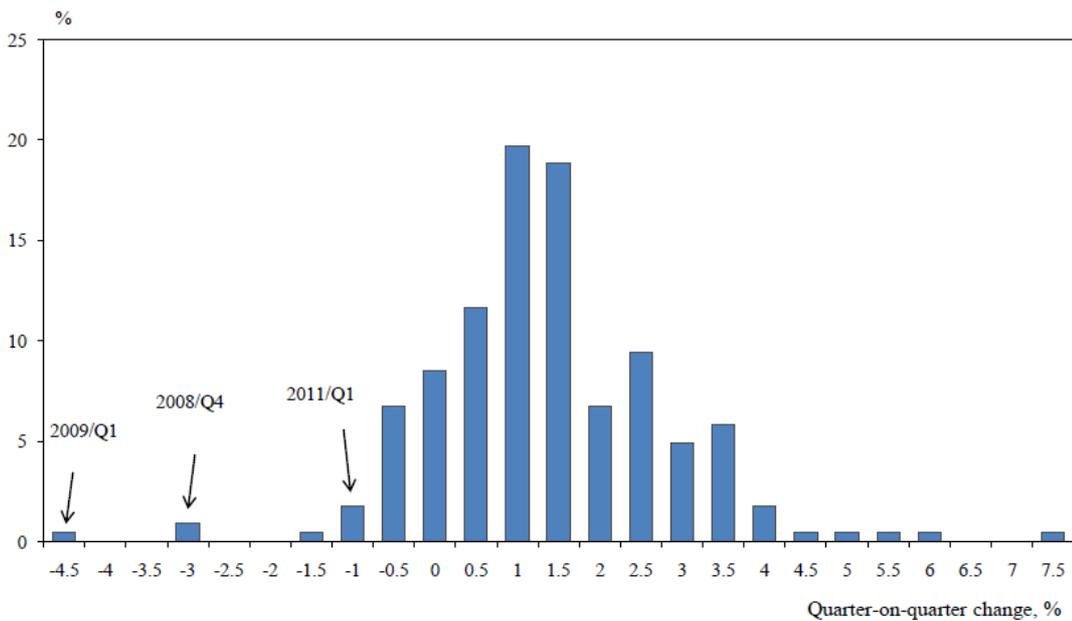


### Frequencies of Natural Disasters



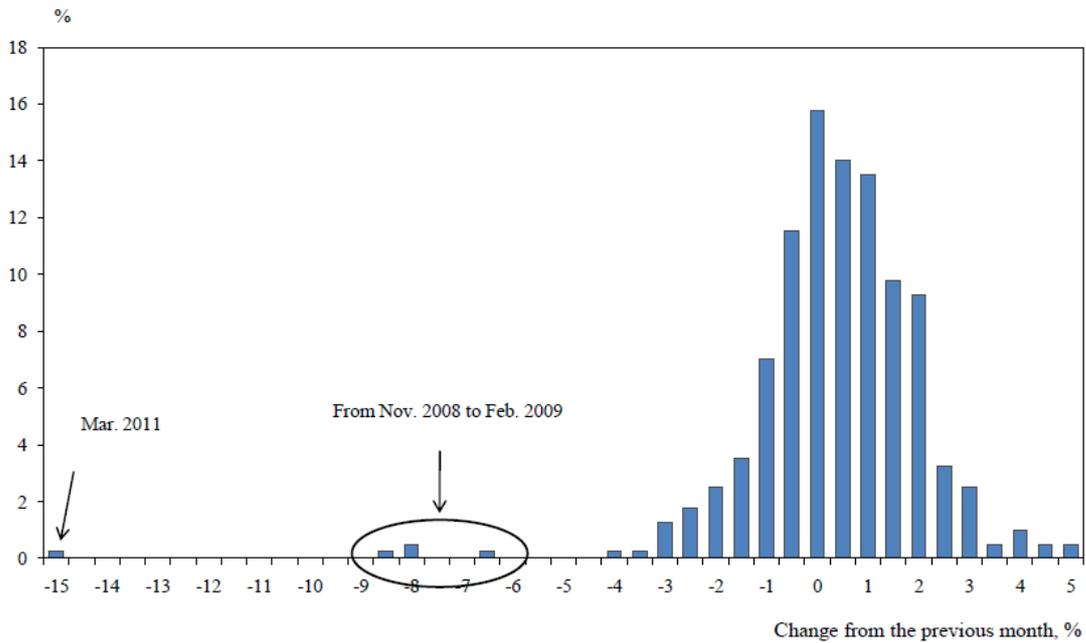
Notes: 1. The damage cost of the Great East Japan Earthquake is estimated by the Cabinet Office to be 25 trillion yen. It is converted into U.S. dollars at the exchange rate at the end of March 2011 (\$1 = 82.84 yen).  
 2. Damage costs include the damage to infrastructure, agricultural crops, and buildings.  
 Source: Center for Research on the Epidemiology of Disasters, University Catholique de Louvain, "Emergency Events Database (EM-DAT)."

### Distribution of Quarterly Changes in Japan's Real GDP



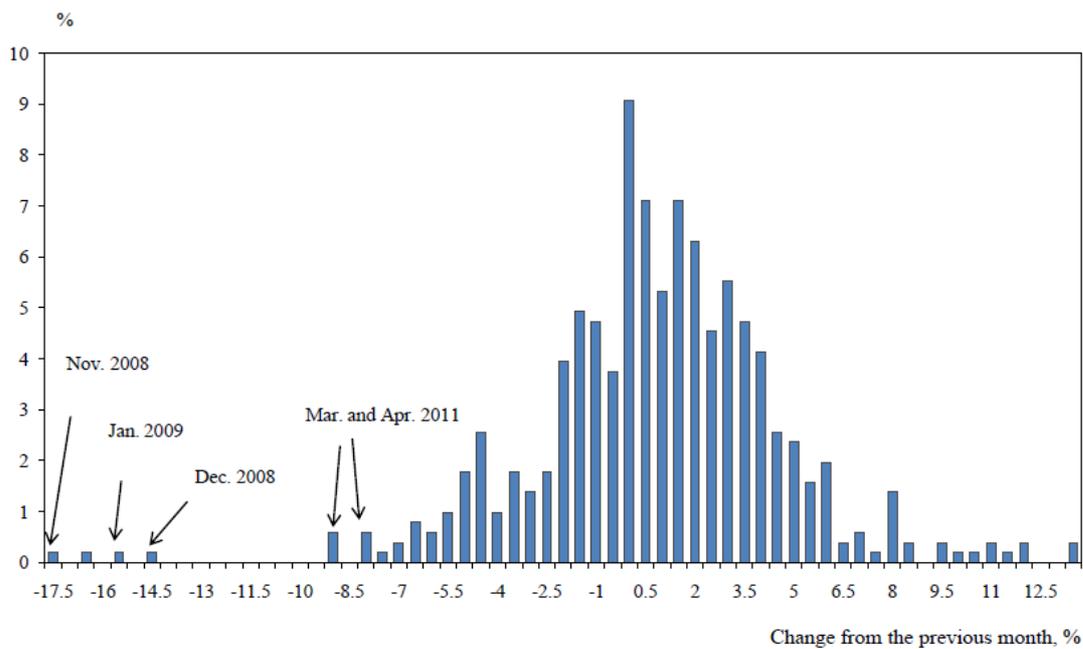
Note: Data from 1955/Q3 to 2011/Q1 are used.

### Distribution of Monthly Changes in Japan's Production



Note: Data from February 1978 to April 2011 are used.

### Distribution of Monthly Changes in Japan's Exports



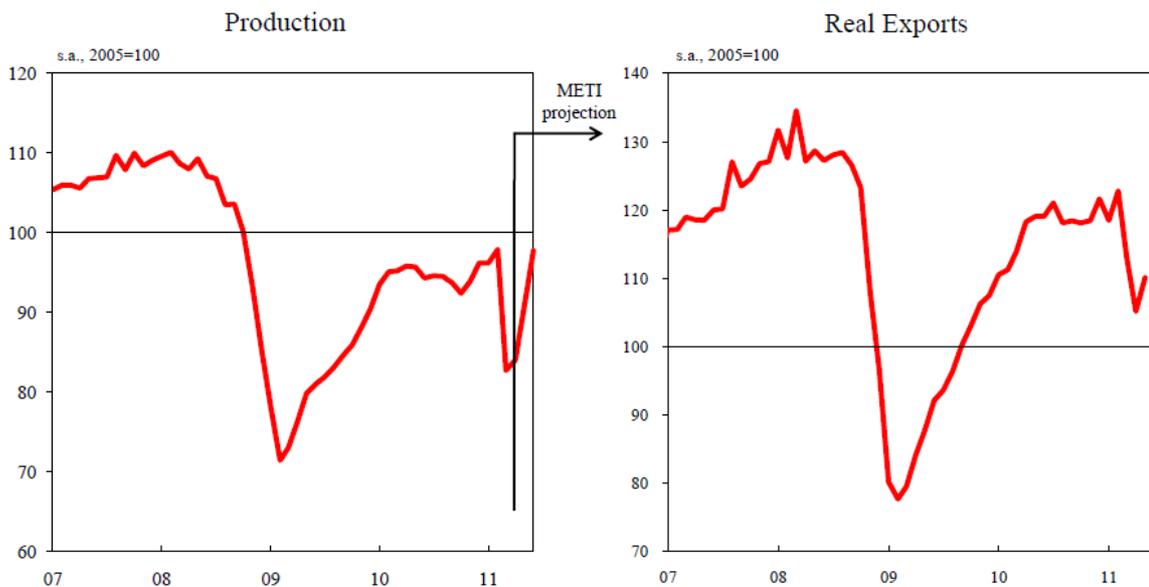
Note: Data from February 1969 to April 2011 are used.

### Damage to Capital Stock

	Amount of damage to capital stock		
		Ratio to nominal GDP	Ratio to total capital stock
<b>Great East Japan Earthquake (2011)*</b>	<b>16-25 trillion yen</b>	<b>3-5%</b>	<b>1.4-2.2%</b>
<b>* Figures do not include the effects of the nuclear accident.</b>			
Great Kanto Earthquake (1923)	4.6 billion yen	29%	9%
World War II (1941-45)	64.3 billion yen	86%	25%
Great Hanshin Earthquake (1995)	9.9 trillion yen	2%	0.9%

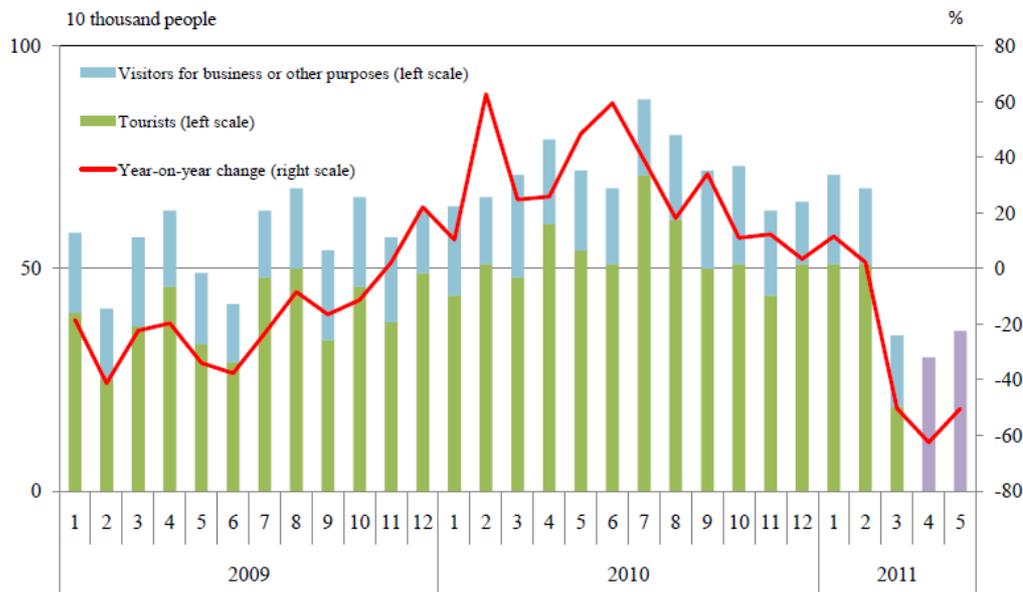
Sources: Cabinet Office; Hyogo Prefecture; Bank of Japan, etc.

### Japan's Production and Real Exports



Sources: Ministry of Economy, Trade and Industry, "Indices of Industrial Production"; Bank of Japan, "Real Exports and Real Imports."

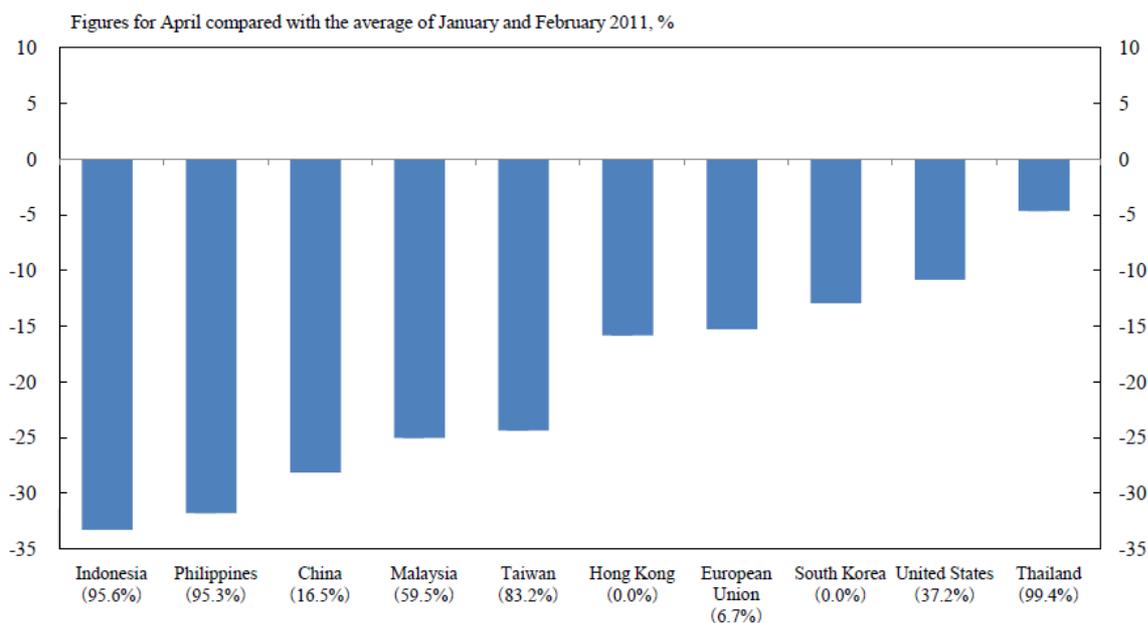
### Number of Foreign Visitors to Japan



Note: Figures of April and May 2011 are estimates of the Japan National Tourism Organization, and a breakdown of the figures by purpose of visit is not yet available.

Source: Japan National Tourism Organization, "Visitor Arrivals & Japanese Overseas Travelers."

### Japan's Exports of Automobile Parts



Note: The parenthesized figure is the share of Japanese automakers in individual economies' automobile production.

## Nominal GDP, Land Size, and Population in the Prefectures Most Affected by the Great East Japan Earthquake

Share, %

	Ibaraki Prefecture	Miyagi Prefecture	Fukushima Prefecture	Iwate Prefecture	<b>Total</b>
Nominal GDP	2.3	1.6	1.5	0.9	<b>6.3</b>
Land size	1.6	1.8	3.6	4.0	<b>11.1</b>
Population	2.3	1.8	1.6	1.0	<b>6.8</b>

Notes: 1. Figures for nominal GDP are as of fiscal 2008. Those for land size and population are as of fiscal 2010.

2. Land size refers to land area as a percentage of Japan's overall size.

Sources: Ministry of Internal Affairs and Communications, "Statistical Handbook of Japan 2010," "Population Census"; Cabinet Office, "Kenmin Keizai Keisan Nenpo (Annual Report on Prefectural Accounts)."