

# Stress Testing at Major Financial Institutions: Survey Results and Practice

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# Stress testing at major financial institutions: survey results and practice

based on the report issued by a WG established by the CGFS (January 2005)

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May 2006

Bank of Japan

Yuko Kawai





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This presentation package is intended to summarize the results of the survey and discussions conducted by the Working Group established by the Committee on the Global Financial System (CGFS), BIS. The Working Group issued the report titled “Stress testing at major financial institutions: survey results and practice” in January 2005, which is available for download from BIS website ([www.bis.org/publ/cgfs24.pdf](http://www.bis.org/publ/cgfs24.pdf)).

Please note that the report was published in January 2005, based on the results of the survey conducted in 2004, hence the contents of this presentation does not reflect market/practice updates between the publication date and now. Also, the presentation includes the speaker’s personal opinions, which may or may not be supported by WG above mentioned or by Bank of Japan.





# AGENDA

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## **1. Outline of the survey conducted by CGFS WG**

## **2. The practice of stress testing**

- Definition, Types and Roles
- Coverage, Formulation

## **3. Details**

- Scenario examples
- Market risk, Credit risk, other risks
- Funding liquidity, Market liquidity
- New products
- Integration

## **4. Conclusions**



# 1. Outline of the survey conducted by CGFS WG



# Stress Test Survey

## WG of CGFS

- Year 2000 : 1<sup>st</sup> Survey
  - Report published in April 2001
- Year 2004 : 2<sup>nd</sup> Survey (chaired by Bank of Japan)
  - Report published in Jan 2005
  - Local survey conducted in 2002 [Japan]

*Collection of private sector stress tests conducted by each institution, not the macro top-down stress test exercise*

## Participants and methods

- 62 financial institutions from 16 countries (mainly banks)
- Collected real stress tests as of **May 31 2004**
- Conducted follow-up interviews

Two years ago...

- Oil prices were just starting to rise
- Markets expected US rate hikes

AND

- Implementation of Basel II was at the preliminary stage at many banks



# Developments from 2000 to 2004

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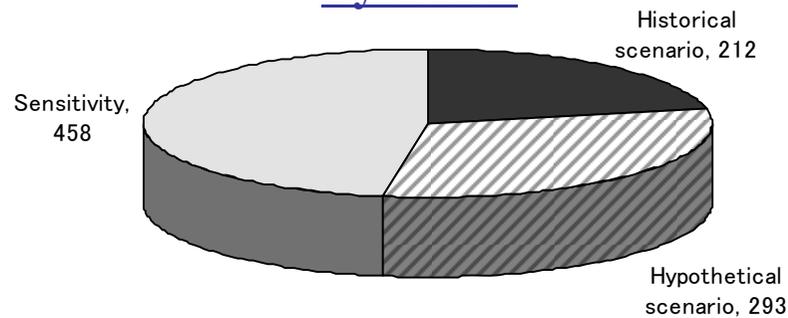
## Developments observed between the last survey (year 2000) and this survey (year 2004)

- Stress tests are used more broadly
  - Wider range of applications
  - Wider range of coverage
- Stress tests vary by institution
- Issues to be solved
  - Stress testing on credit risk
  - Integration of risk management

# Overview of the survey results

- Total number of tests collected: 963

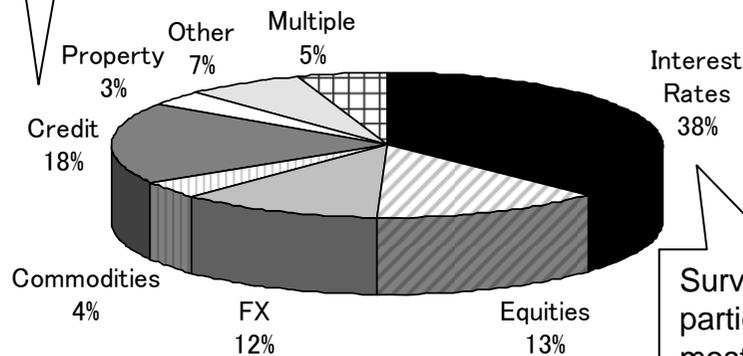
## By TYPE



Not necessarily covering the full range of risks expected to realize in the markets with certain probabilities, rather, the risks related to the direct exposures

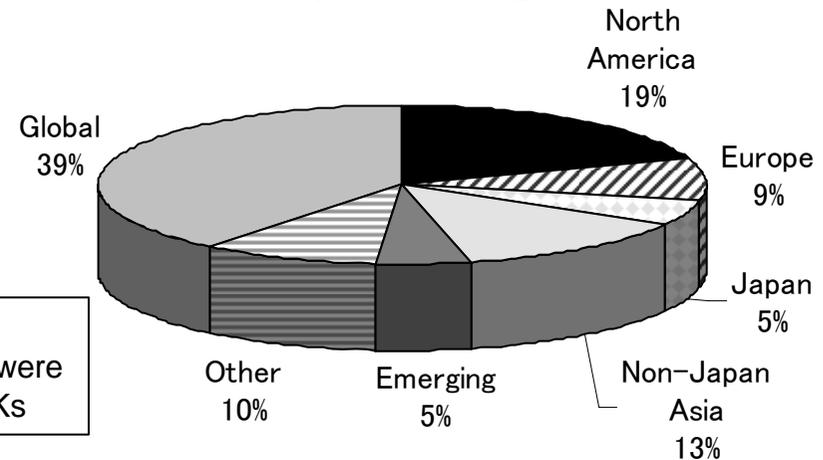
Influenced by then-prevailing market environments: we may see more CREDIT today

## By RISK



Survey participants were mostly BANKS

## By Risk Region





## 2. The practice of stress testing



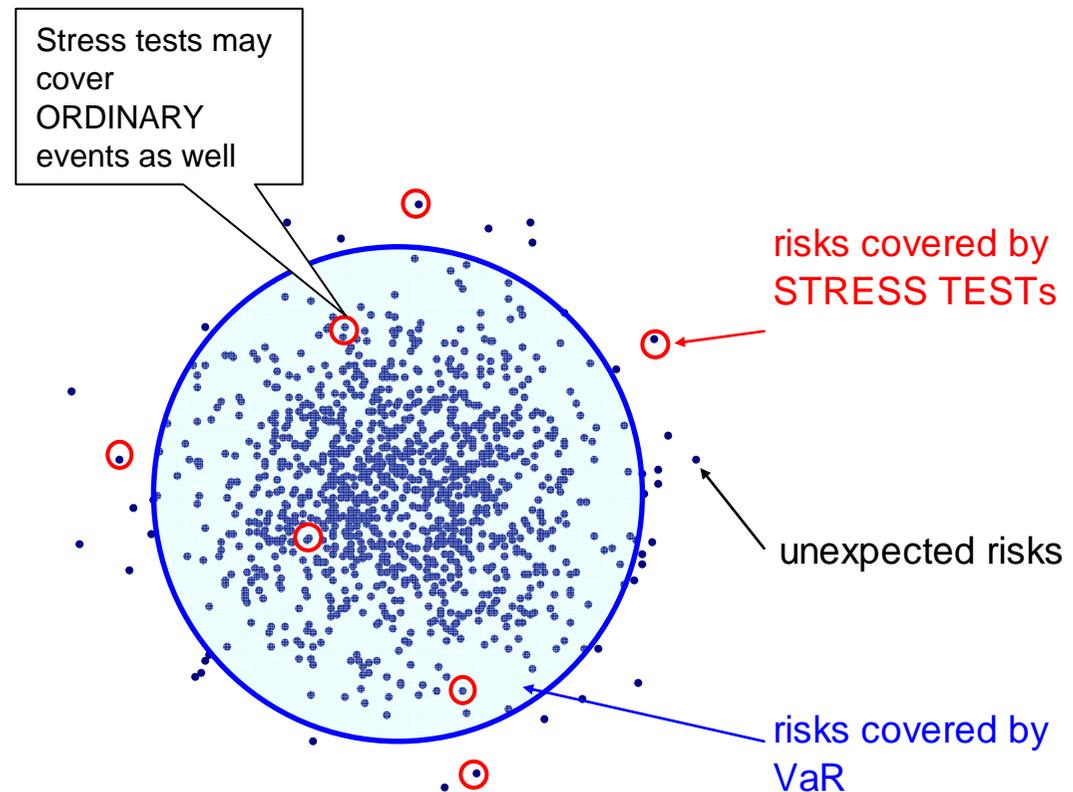
# Definition

## Definition

- Risk management tool used to evaluate the potential impact on a firm (or a division) of a specific event and/or movement in a set of financial variables

## A complement to statistical models such as VaR

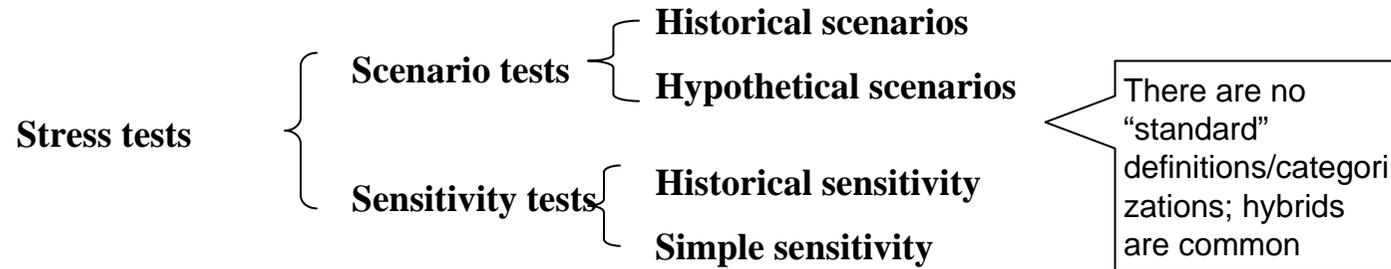
- VaR: capturing risks as a plane
- Stress test: capturing risks as points



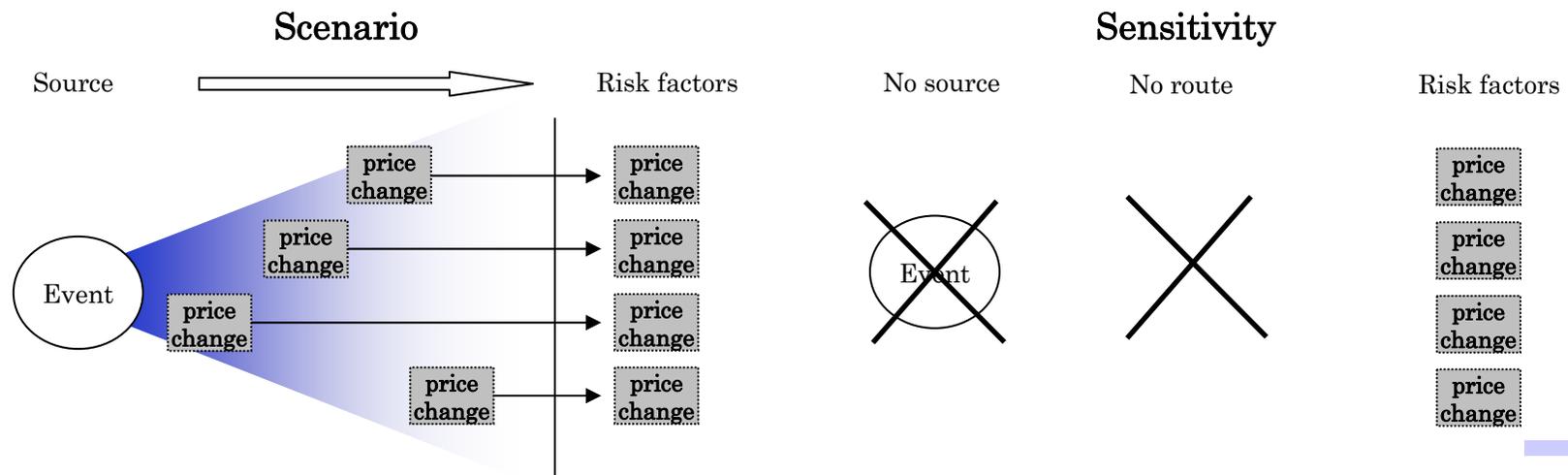


# Types

- Stress tests generally fall into two categories
  - Scenario tests : Assume the background (i.e., source of risk) of stress
  - Sensitivity tests : Only risk factors specified



## Scenario vs. Sensitivity



# Roles

- Stress tests work as a “communication tool” and/or “risk management tool”  
→ Formulation/running frequency depends on the purpose
- The roles are not mutually exclusive; one stress test may have multiple roles

## Communication tool

A. Analyze the risks under the concern of management

B. Capture the impact on a portfolio of exceptional but plausible large loss events

C. Allocate/verify the limits/capital

D. Evaluate business risk

E. Understand the risk profile

F. Measure the sensitivity of portfolio

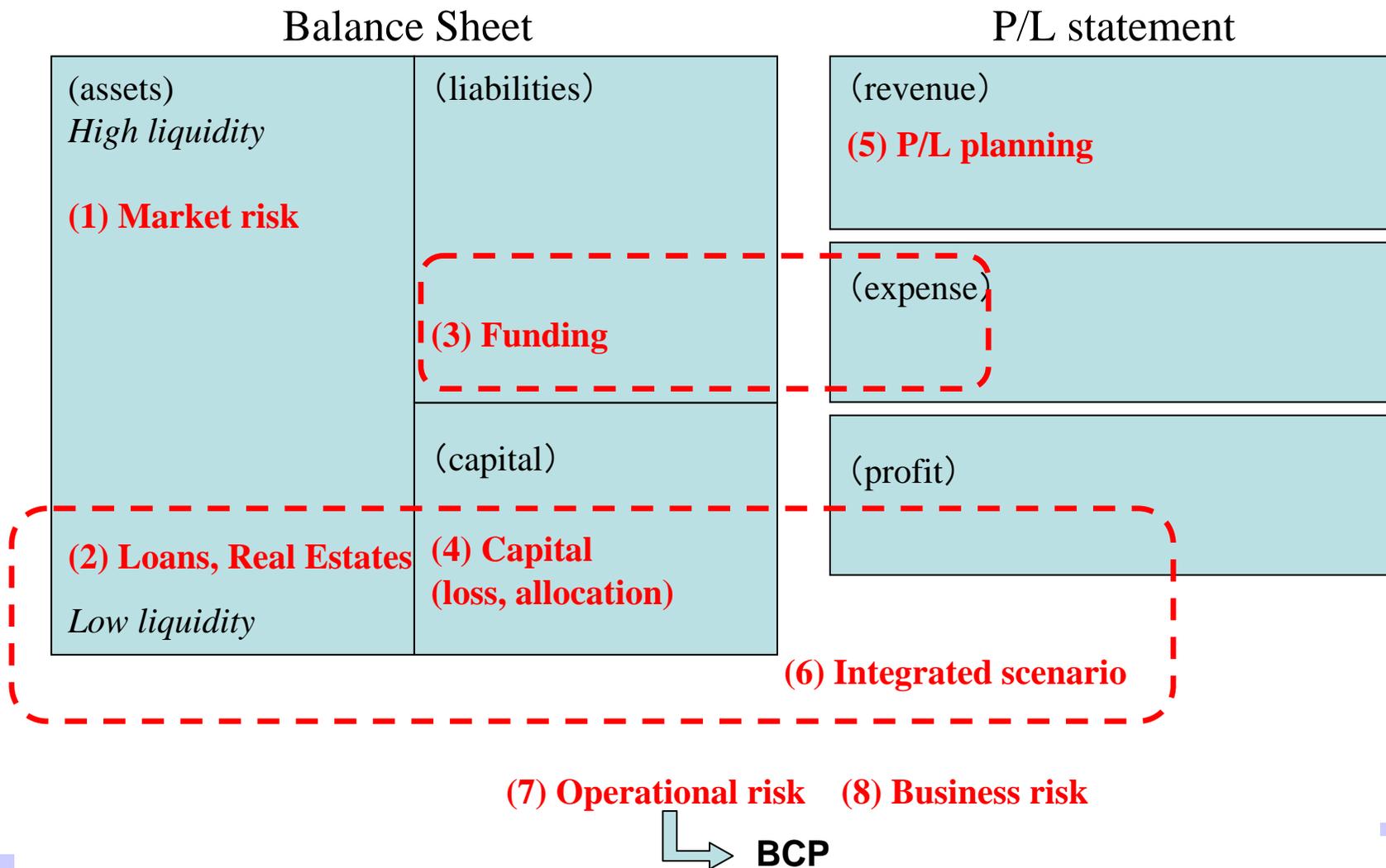
G. Inputs to VaR

H. Measure risks outside of VaR

**Risk management tool**

# Coverage

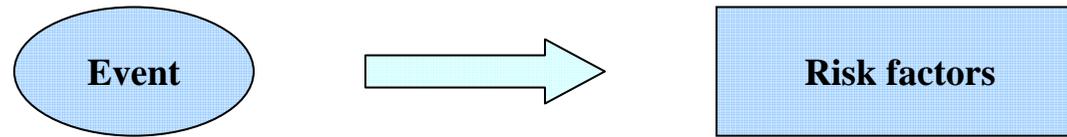
- Various parts of a company's financials are covered





# Formulation

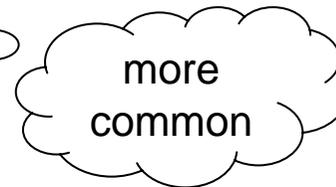
- Event-driven approach
  - What will happen if... ?



(Step 1) Identify a risk source which causes changes in financial markets

(Step 2) By how much do risk parameters change if such an event occurs?

- Portfolio-driven approach
  - When do we lose money?



(Step 2) What events might bring about these changes?

(Step 1) What are the risk parameter changes which result in a portfolio loss?



# A. Analyze the risks under management's concern

## Purpose

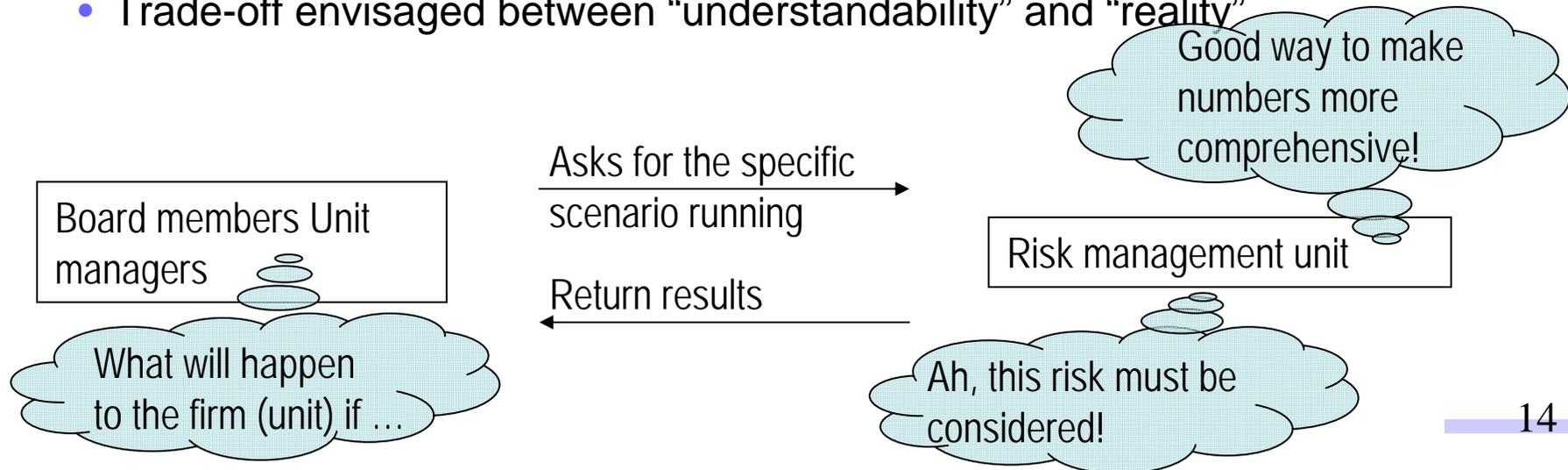
- Know what risks are under the attention of managements, and measure their impacts

## Examples

- Conduct the test to measure the influence on a bank's portfolio of a hypothetical prolonged Iraqi War/terrors

## Formulation

- By the request of managements
- Event-driven approach
- Trade-off envisaged between "understandability" and "reality"



## B. Capture the impact on a portfolio of exceptional but plausible large loss events

### Purpose

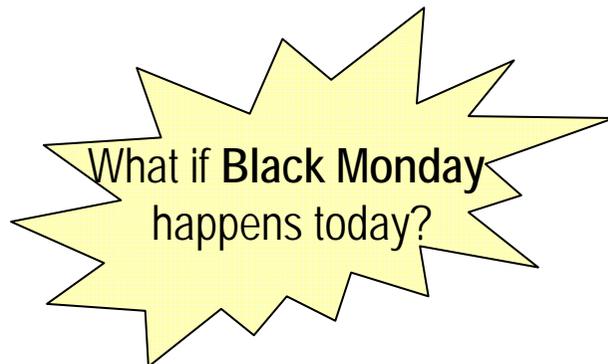
- Measure the impact of exceptional but plausible large loss events
- Trigger to the contingency plan

### Examples

- Calculate the today's loss to be caused by Black Monday

### Formulation

- Mainly Portfolio-driven approach
- Sensitivity analysis and Historical scenarios are more applicable
- May focus on short-term impacts
- May set risk parameters outside of VaR assumptions



## B. Capture the impact on a portfolio of exceptional but plausible large loss events

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### Multi-factor sensitivity analysis

- Size of risk factors
  - The worst data during the observation period
  - The standard deviation for the observation period times multiplier (e.g., a number larger than the VaR assumption, data during the stressed period)
  - Unit change (e.g. +1%、-5pts)
- Combination of risk factors
  - Add-up of the worst data
  - Based on certain risk scenarios
  - Correlation assumed
- Holding period
  - From the peak to the bottom, unit periods
- Observation period
  - Conservativeness vs. plausibility

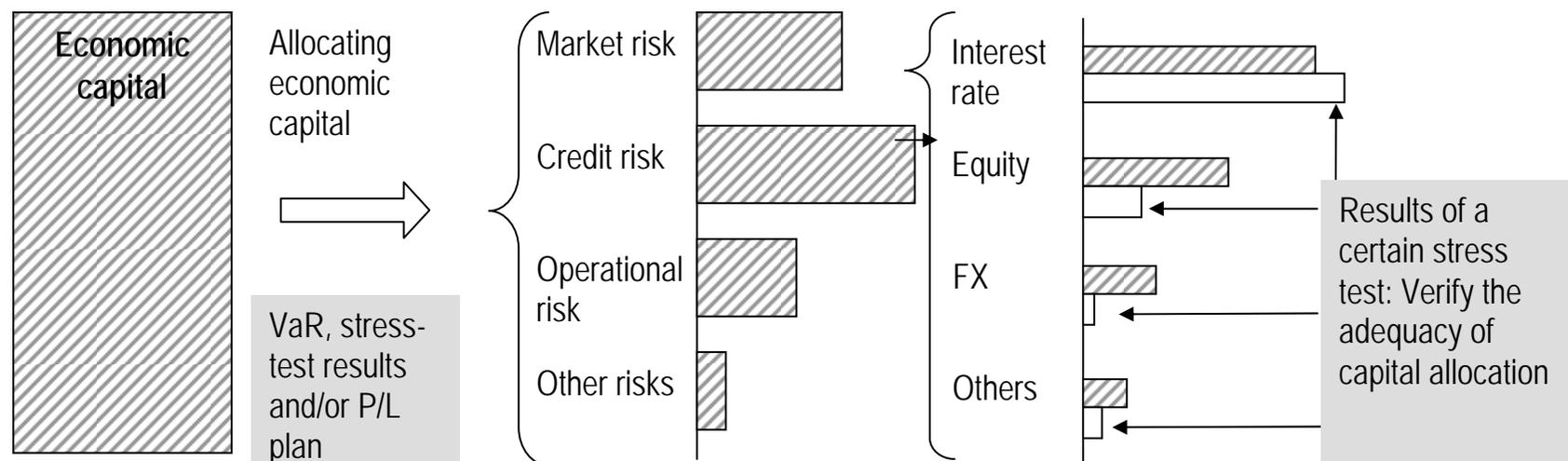
# C. Allocate/verify the limits/capital

## Purpose

- Direct/indirect inputs to the allocation of economic capital and/or risk limit settings
- Verify/diagnose the adequacy of allocation/limits otherwise established

## Examples

- Confirm that the loss under stress will not exceed the allocated capital



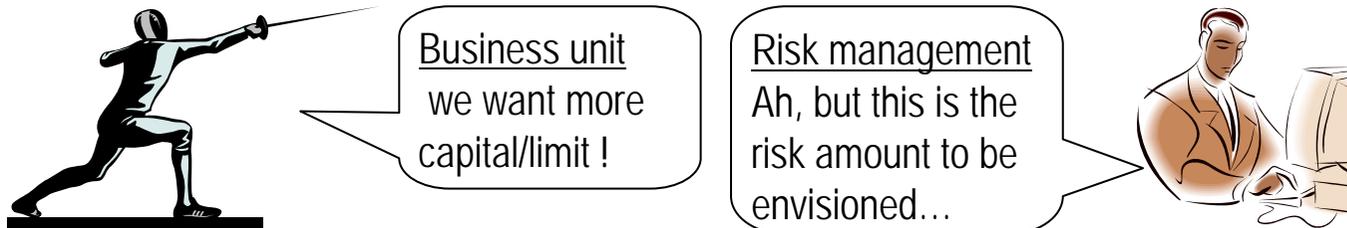
# C. Allocate/verify the limits/capital

## Formulation

- Event-driven approach
- Scenarios normally assume risk durations as long as 1 year
- Include low-liquidity risks (e.g. loan portfolio, real estates related)

### (If used as direct inputs)

- Subjectivity (with reasonable plausibility) is a key
  - Economists, traders maybe involved from the early stage
  - Alternatively, worst case historical scenarios may be applied
- Macro models maybe employed
- Probability maybe assigned to stress scenarios (EVT-Extreme Value Theory)
- Feedback effects must be considered



## D. Evaluate business risks

### Purpose

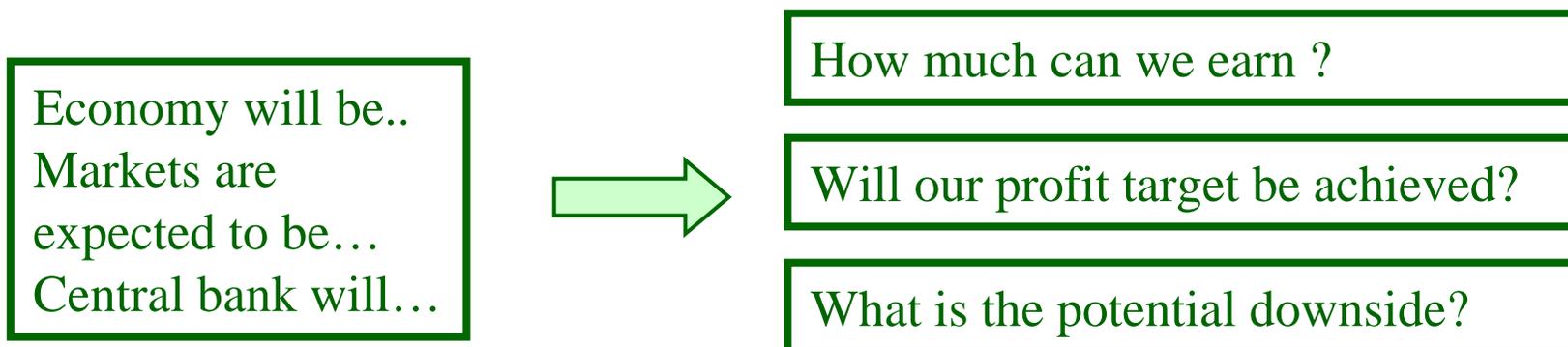
- Inputs to the determination of the annual P/L plan and/or verification of such plan

### Examples

- Main underlying scenario is the gradual recovery of economy, while stressed risk scenario is the sudden acceleration

### Formulation

- Same as C (previous slide)
- Include risk factors affecting P&L (not only asset value)



# E. Understand the risk profile

## Purpose

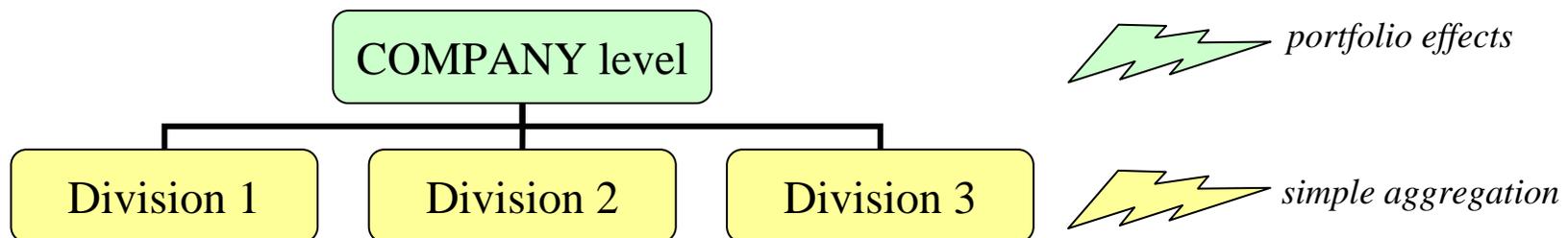
- (1) Identify the concentration risk for the whole company (across divisions/products)
- (2) Identify the risk diversification effect (one division's risk maybe offset with the others')

## Examples

- (1) Calculate the effect of default of one big company (such as a US automaker) over credit/equity/counterparty risk portfolios
- (2) Measure the effect of the long-term interest rate rise coupled with stock price rise (e.g. summer 2003, Japan)

## Formulation

- Event-driven approach





# G. Inputs to VaR

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## Purpose

- Inputs to VaR risk measurement

## Examples

- Determine the probability distribution used to calculate VaR, based on the sensitivity test result for each asset class and its correlation to other parameters under the stressed situation

## Formulation

- VaR itself requires the periodical back-test
- Historical scenario/sensitivity (in order to claim the subjectivity)





# H. Measure risks outside of VaR

## Purpose

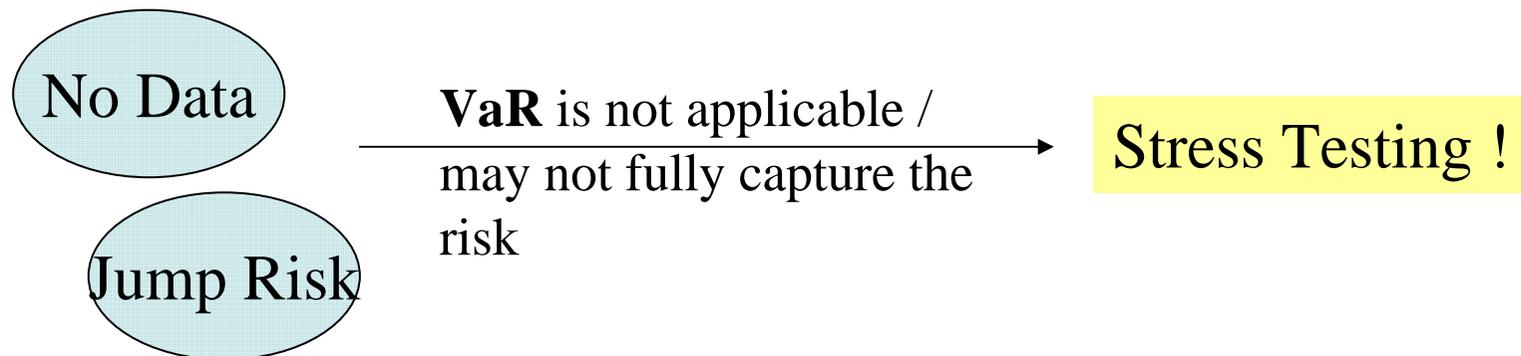
- Measure the risk which by definition is not captured by VaR

## Examples

- Cessation of currency peg (no historical data)
- Risk measurement of brand-new products (no historical data)
- Non-linear profile risks

## Formulation

- Portfolio-driven approach
- Cover the risks where statistical approaches are of no use





# 3. Specific Issues





# Specific Issues

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- Scenarios
  - List of risks covered
  - Major scenarios
- Market Risk
  - Interest rates, Equities, FX
- Real Estate Risk
- Credit Risk
- Integration of risk management
- Others
  - Funding liquidity
  - Market liquidity
  - New products



# Scenarios

- Major historical scenarios
  - Selection depends on the institution

**As of May 2004**

Year	Event
1973	Oil shock
1987	Black Monday
1990	Gulf War
1992	EMS crisis
1994	Interest rate rise (global)
1994	Mexican Peso crisis
1995	European bond price drop
1997	Asian crisis
1998	Russian default
1998	LTCM failure
1998	USD/JPY nosedive

Year	Event
1998	Financial systemic crisis (Japan)
2000	IT bubble burst
2000	US credit deterioration
2000	Argentina crisis
2001	US Terrors
2002	US accounting scandals
2002	ABS spread widening
2003	Iraqi invasion
2003	Interest rate rise (global)
2003	GSE spread widening (US)
2003	SARS outbreak

Major scenarios : blue-shadowed

# Scenario examples

## Historical [Hypothetical] scenarios

Source	Scenario
Economy/Fiscal policy	
Global Economy	[Recovery][Recession]
Japanese Economy	[Recovery][Recession]
US Economy	[Recovery][Recession]
European Economy	[Recession]
Emerging Economy	Argentina crisis, Russian crisis, Mexican Peso crisis, [Moratorium of specific country]
Asian Economy	Asian crisis
Inflation	[Inflationary fear]
Monetary Policy	
BOJ monetary policy	[rate hike][lift of quantitative easing policy]
FRB monetary policy	Policy change (1993) Rate hike(1994)
Other monetary policy	[rate hike][rate cut]
Geopolitical risk/Terrors	
Terror	9-11, Madrid train terror, [local terror]
Geopolitical (Middle East)	Iraqi invasion, Gulf War
Geopolitical (Asia)	[North Korea]

Source	Event
Exogenous events	
Real Estate price	price drop
Oil	Oil shock
Other commodities	[Price up/down]
Catastrophy	Earthquake, outbreak of SARS
Politics	[cabinet resignation][assasination of VIP]
Financial system, corporate sector	
Banks specific	[own downgrade]
Corporate sector	accounting scandal, [downgrade of loan borrowers]
Financial system	LTCM, Japan(1997-9)
Financial Market	
Foreign Exchange	USD drop, EMS crisis, [de-peg of currency]
Equity	IT bubble crash, Black Monday
Interest Rate	Global interest rate rise (1994, 2003)
Other products	GSE/ABS spread widening, [credit derivatives turmoil][hedge fund crisis]



# Market Risk (1) Interest Rates

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## Background to scenarios

- Economic recovery, Inflation fear, Monetary policy change, Selling pressure in the market.. etc.
  - Gap between the market recognition and the reality

## Risk factors

- Interest rate for each tenor/currency, shape of yield curve, volatility
- Basis (cash-future), currency basis, TED spread, NII

# Market Risk (2) Equity

## Background to scenarios

- Economy, Terror (geopolitical risk), Oil surge, Political turmoil, Accounting scandal... etc.

## Risk factors

- Stock price (individual, index, by industry, beta), Volatility, Correlation/spread (for long-short strategy)

### Historical scenario examples (equity price drop)

Year	Event
1987	Black Monday
1990/91	Gulf War
1997	Asian crisis
1998	Russian crisis/LTCM default
2000	IT bubble burst
2001	9-11 terror
2002	US accounting scandal



# Market Risk (3) FX

## Background to scenarios

- Political turmoil, De-peg, Fiscal deficit, Financial market crisis (especially in the emerging market)... etc.
  - There are equity drop/credit spread widening scenarios with FX as a “source” of shock

## Risk factors

- FX rate (rise/fall, de-peg), volatility

### Historical scenario examples (FX rate change)

Year	Event
1992/93	EMS crisis
1997	Asian crisis
1998	Russian crisis/LTCM default
1998	USD nosedive against JPY
2000	IT bubble burst
2001	9-11 terror
2002	US accounting scandal





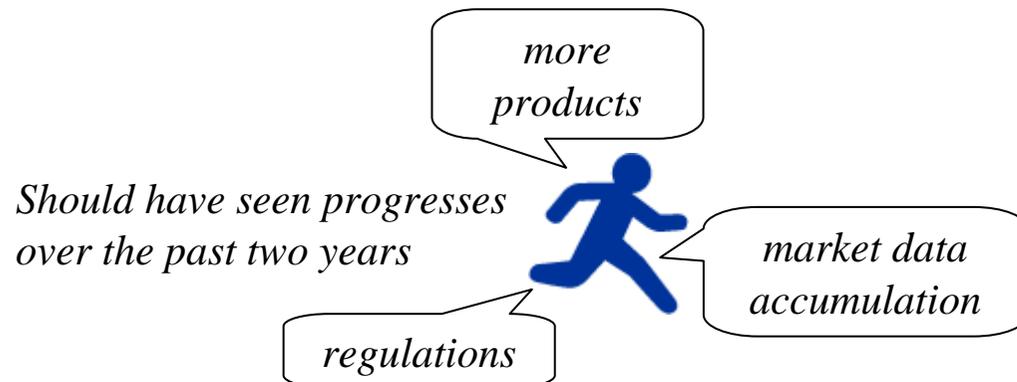
# Credit Risk

## Background to scenarios

- Macro factors such as Economy, Unemployment Rate
  - May use macro-model
- Real estate price drop, terror, financial market crisis, accounting scandals... etc.

## Risk factors

- <for non-market exposures> Loan outstanding, Loan classification (regulatory), Internal borrower ratings, Loss given default, Collateral value, Probability of default
- <for market exposures> Credit spreads, swap spreads, index value





# Issues (as of 2004/5) in Credit Risk management

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## Integration of risk management

- Integrated framework to cover full range of “credit” exposures
- Steps of credit risk management
  - Capture >> hedge >> active trade
- Specific issues

## Integration of risk scenarios

### LOANS

- Accrual accounting
- Market price hardly available  
(PD/LGD risk factors)
- Loan booking system
- Banking book...

### CORPORATE BONDS/CDS/STRUCTURED FINANCE PRODUCTS

- Mark-to-market accounting
- Market price (partially) available
- Bond/derivatives booking system
- Banking/Trading book...

*How should we add them up?*



# Credit Risk : capture & measure risk

## Various types of exposures to be covered:

- Common quantity measurement required to add-up risk amount
- Common risk factor to evaluate the whole portfolio
- Market price may not be available for a substantial portion of the whole exposure

### Credit exposure examples

	<b>Risk factors</b>	<b>Market price available?</b>
<b>Loan (borrower)</b>	<b>PD, LGD, collateral value, (credit spread)</b>	<b>Depends on the country and name</b>
<b>Bond (issuer) CDS (reference entity)</b>	<b>spread</b>	<b>Yes</b>
<b>Financial contracts (counterparty)</b>	<b>Spread, collateral value</b>	<b>(almost) No</b>

# Credit Risk: integration

## Risk management evolution <example>

- Capture and add-up risks, reduce the excess
  - Common quantity measurement such as Loan Equivalent amount
  - System integration required to add them up
  - Internal ratings assigned (may be mapped to external ratings)
  - Reduce the over-exposure (sell loans, buy CDS production, securitize...)
- (Quasi) mark-to-market and hedge economic capital
  - Mark all credit exposures (managerial accounting vs. reporting accounting), with some estimations of credit spreads to be marked
  - hedge economic capital
- Dynamic management
  - Actively traded credit markets
  - Buy and Sell the risks, to maximize the enterprise-wide risk-return



# Credit Risk: risk management issues

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## Accounting

- Accrual vs. Mark-to-market
  - Loans (accrual) hedged by CDS (mark-to-market) produces accounting gaps

## Market liquidity

- Market prices are limited to traded names in CDS/Bond markets
  - The loan secondary market is limited in most countries, and SME names are not traded even in the developed markets
  - Mark-to-market necessity vs. unavailability of input parameters

## Data availability

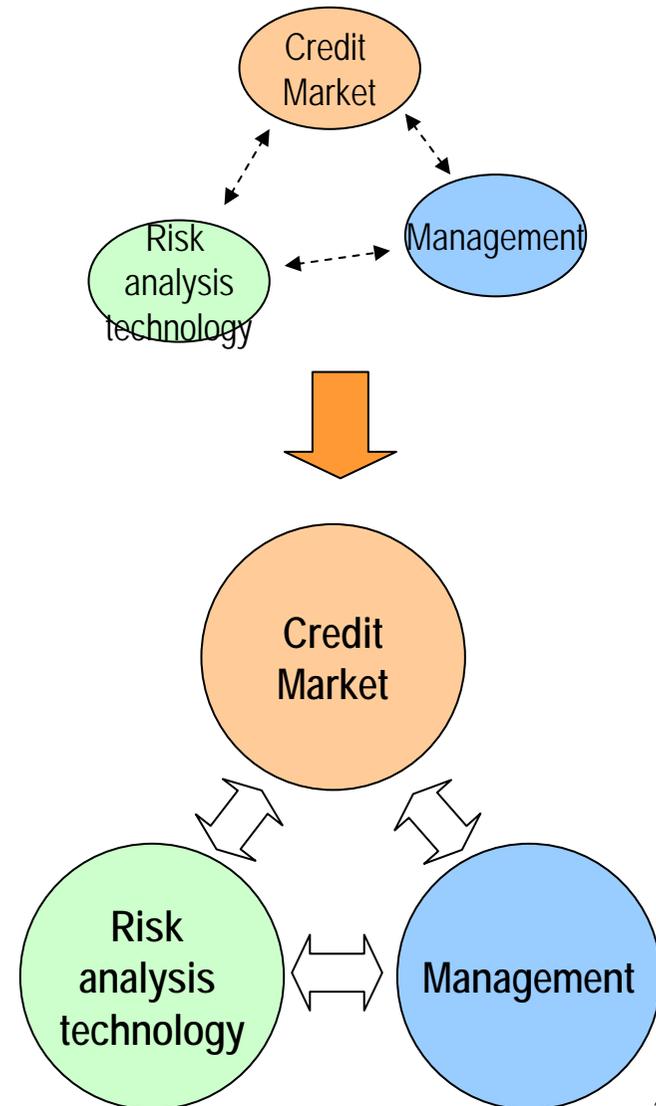
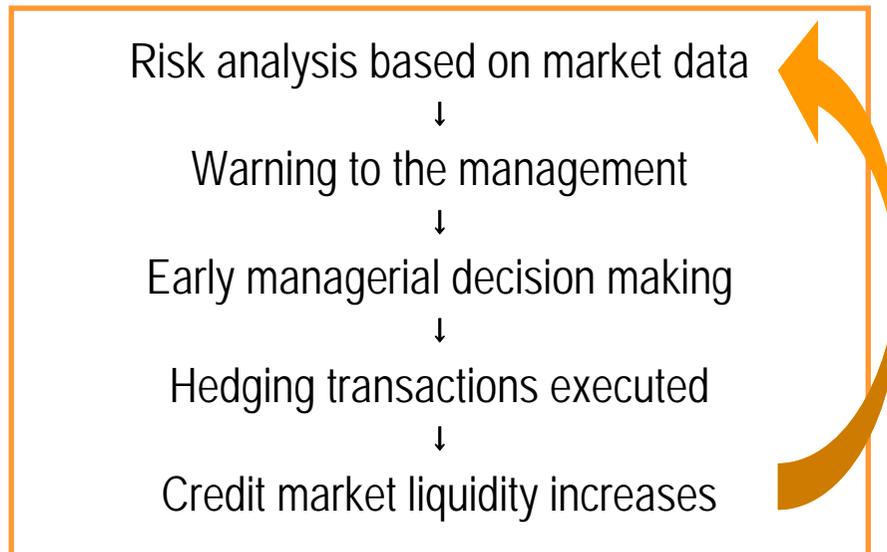
- Default rates/LGDs
- Portfolio correlation

## New risk factors

- Structured finance correlations (CDO, basket/pooled/Index products)
- Basis risk among bond spreads, loan spreads, CDS spreads
  - No historical data >> stress testing!

# Risk management and Market development

As the hedging activities increase (based on risk analysis), the credit market expands and more data become available for risk analysis to further fortify the risk management mechanism





# Credit Risk: Scenario integration

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## Macro economic model

- Example 1: Simulate macro factor (such as unemployment rate) change over collateral value/corporate sector earnings
  - Combined with simulation over market risks (e.g., FX, interest rates), an enterprise-wide testing conducted

## Market factor model

- Example 2: Simulate real estate price drop, with the 1<sup>st</sup> effect on collateral value and 2<sup>nd</sup> effect on corporate credit deterioration
  - 3<sup>rd</sup> effect over market risks maybe combined
  - Trigger could be other risks (e.g., interest rates)



# Other risks

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## Real Estates

### **Background to scenarios**

- Slowdown of economy
  - Real estate price drops are mostly given as exogenous risk factors

### **Risk exposures being tested**

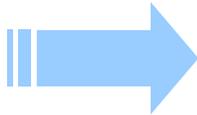
- Real estate price (direct holding/collateral to loan), mortgage loan value
  - Measuring direct impact of holdings/loan value
- Generic default probability/recovery ratio of loans
  - Measuring indirect impact on overall loans
- Influence to FX/equity
  - Measuring effects on market risks

Other risks: Commodities, Emerging economy events... etc.



# Funding liquidity

- Fluctuation of funding needs
  - Withdrawal of deposits (insurance contracts, funds) or difficulty in market financing
    - (possible cause) own downgrade, change in economy
  - Increased drawdown of commitment lines
    - (possible cause) borrower's credit deterioration
- Rise of funding costs
  - Own credit deterioration
    - ← alternative finance tools, back-up lines
  - External event-driven (e.g., terror, financial systemic crisis)
    - ← support from central banks assumed



- May lead to trigger contingency plans
- Succeeding set of tests to evaluate the liquidation of collateral/own assets for financing





# Market liquidity

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- No magic solutions
  - Use empirical data
  - Extend the holding periods / widen the range of price change
  - Distinguished the low-liquidity assets and apply conservative parameters
- Feedback effect [amplification of a negative market trend owing to loss-cutting transactions by the institutions themselves]
  - May assume certain price changes (tough to quantify)
- Aftermath of Major dealer exit
  - Game-theory?
  - May assume certain price changes/liquidity draining





# New products

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- Spreads of structured finance products
  - ABS, CDO, MBS
- Basis risks
  - CDS-bond spread
- Correlation risks
  - Credit correlation (basket/pool)
  - Cross-product correlation (e.g., equity-credit)
- Hedge Fund (index)





# Integration of Risk Management

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## **Organization**

- Common reporting line

## **Sum-up of similar risks**

- System integration
- Common measurement of exposure quantity
- Common risk factor

## **Common event/scenario setting**

- Applicable to all products and divisions
- Applicable to assets, liabilities, and P/L

## **Recognition/evaluation of concentration/diversification**

- Consider diversification effect in allocating capital

## **Integration to include operational risks?**

- Common scenarios maybe applied





# 4. Conclusions





# Conclusions of the Report

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## **Stress testing is becoming more integrated into risk management frameworks**

- Various roles, not limited to the tool to capture exceptional risks

## **Credit risk management is a key focus for most institutions**

- Practice varies by institution and/or by market, while the most advanced institutions claim there still are issues
- Development of credit derivatives market may support the mark-to-market approach

## **Integration of risk management has various aspects, such as a common platform and an enterprise-wide scenario**

## **Dry-up of market liquidity is being noticed, while no legitimate risk measurement is invented yet**





# Some thoughts...

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## **Stress testing is evolving dynamically,**

- Stress testing started as an attempt to measure the risks which are not appropriately captured by regular statistical methods, such as VaR
- Now the applications of stress testing are expanding dramatically

## **With its flexibility as a key element;**

- Flexibility and affinity to the institution's risk profile are the hearts of stress tests

## **Therefore, there is no ideal “framework” / “single exponent” of stress testing**

- Each institution builds its own set of stress testing, depending on its portfolio/risk profile, market environment, expected roles of stress testing.

# In reading survey results ..

- The list of scenarios/parameters is not a complete set of the likely events expected by market participants
    - Institutions choose risk parameters to affect their risk profile (e.g. interest rate up vs. down, fall in equity prices vs. rise), and may not pick up the changing leading to profits
  - “Stress test” may mean completely different type of tests, depending on who uses the term
    - ***Macro tests to check Financial Stability (FSAP type) vs. each institution’s risk management (covered by this survey)***
    - Market risk only vs. including non-market risk
    - VaR supplement vs. stand alone tests
    - Asset evaluation vs. P/L planning, capital allocation
    - Operational risk
- 
- Do not try to read “what are likely future events expected by market participants” through stress test results
  - Be specific in asking practitioners for information