

Stress Testing – from a supervisory perspective

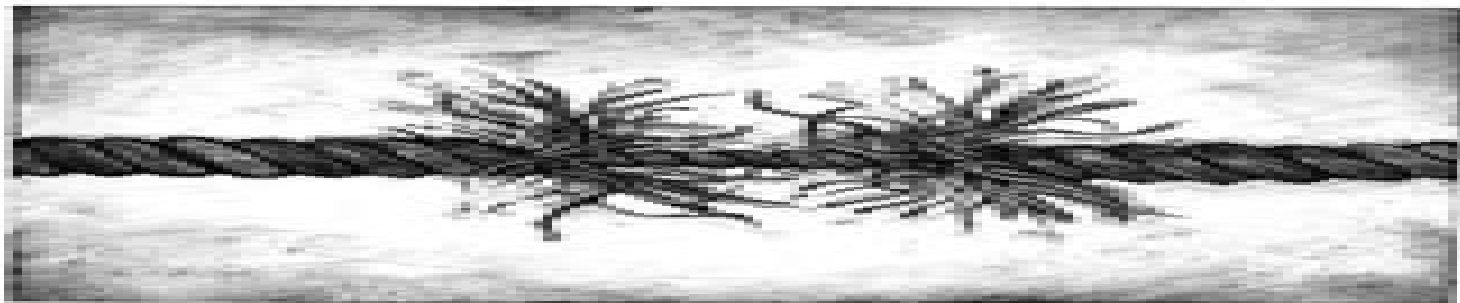
Seminar for Senior Bank Supervisors from
Emerging Economies (Washington DC)
October 21, 2008
Kapo Yuen, Federal Reserve Bank of New York



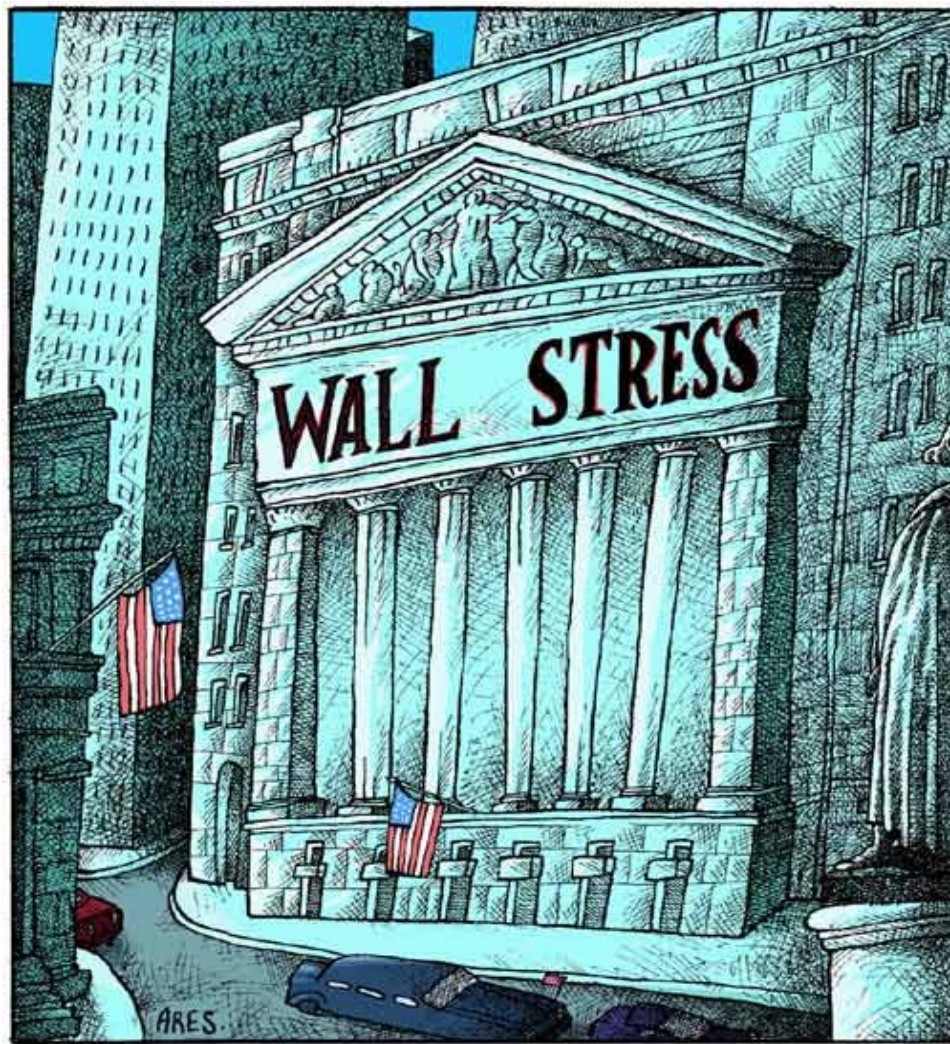
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Agenda

- **Introduction**
- **Historical Perspective - Stress Testing Horizontal at 2006**
- **2007 Market Turmoil Observations**
- **Current Supervisory Requirements**
- **Basel II Stress Testing**
- **Best Practices**
- **Recommendations**
- **Conclusions**



What is Stress Testing?



Source: cartoonbox.slate.com/

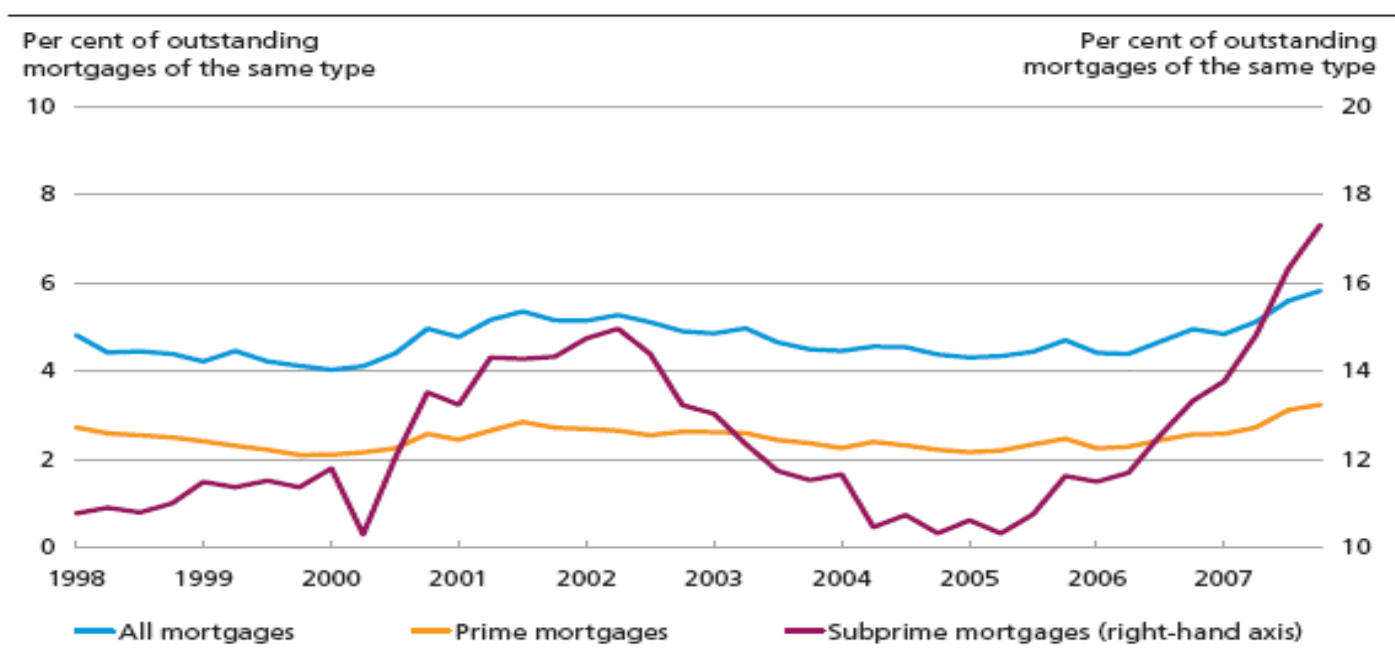
Introduction - Definition

- Stress testing is a risk management tool used to evaluate the potential impact on portfolio values of unlikely, although plausible, events or movements in a set of financial variables.....

www.frbsf.org/publications/economics/letter/2005/el2005-14.html

DEFAULTED MORTGAGES IN THE USA

Chart 3



Source: Bloomberg.

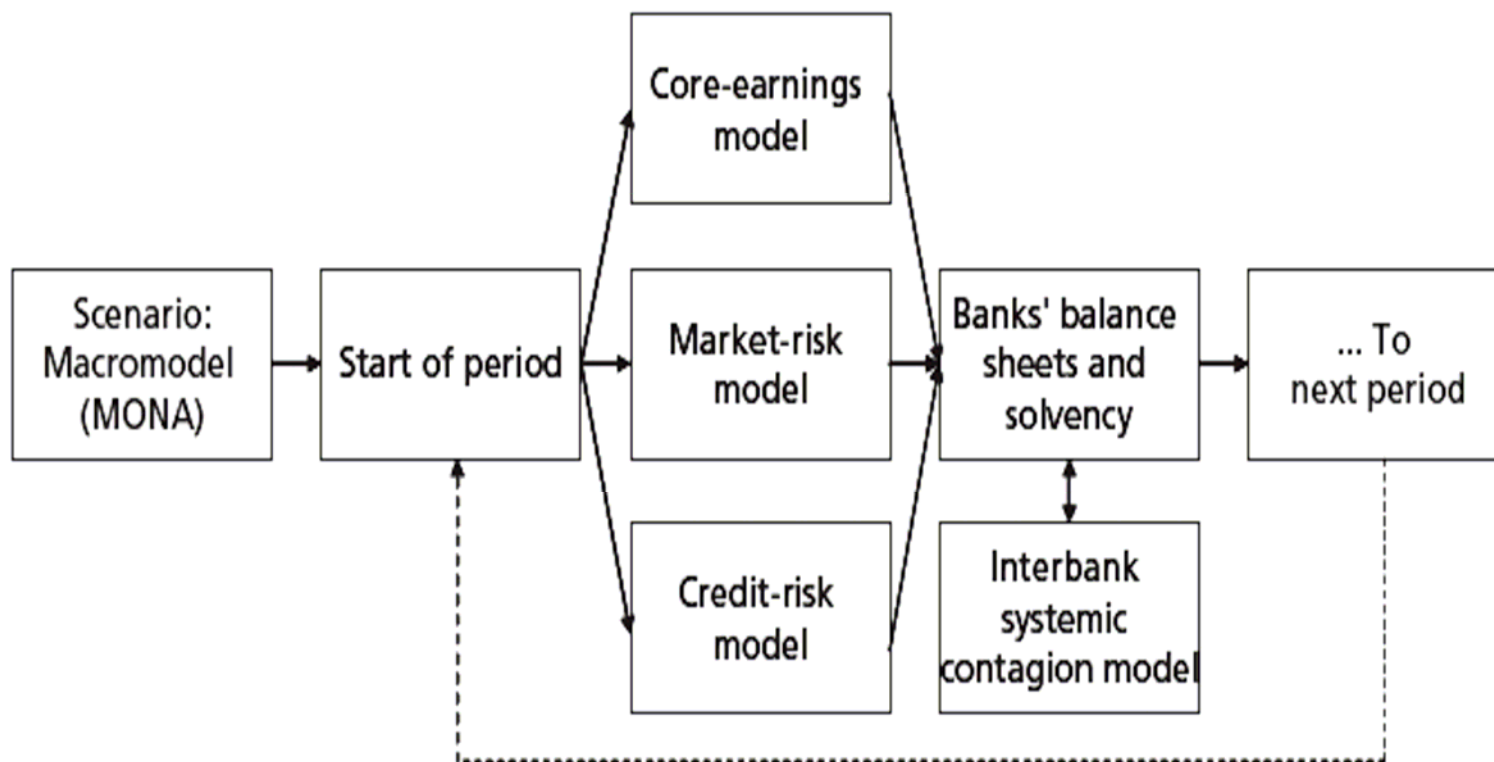
Introduction - Type

- **Two types of Stress Testing:**
 1. **Sensitivity Analysis**
 - 100, 200 basis point increase in yield curve
 - House Price Index decreases by 10%, 25%
 - Credit rating down grades by 2, 3, 4 notches
 2. **Scenario Analysis**
 - **Historical**
 - Black Monday, October 1987
 - Attack on World Trade Center, 09/11/2001
 - Asian Financial Crisis, October 1997
 - Subprime Mortgage Crisis, September 2007
 - **Hypothetical**
 - Forward Looking – forecasting on risk drivers
 - Macroeconomic – mild, moderate, severe recession
 - Extreme Value Theory and Tail Events

Introduction – Framework

STRESS TEST MODEL ARCHITECTURE

Chart 48



Financial Stability, 2008, Danmarks National Bank

[/www.nationalbanken.dk/C1256BE9004F6416/side/Financial_Stability_2008/\\$file/finstab08_uk.pdf](http://www.nationalbanken.dk/C1256BE9004F6416/side/Financial_Stability_2008/$file/finstab08_uk.pdf)

Before 2007 Market Turmoil

Federal Reserve Banks 2006 Horizontal Review on Stress Testing

2006 Horizontal Review

- **Federal Reserve Bank conducted a horizontal examination across 6 large financial institutions (4 domestic, 2 foreign)**
- **Objective was to assess the state of stress testing practices at various institutions, with particular focus on integrated stress tests that capture the inter-relationship among credit, market, operational and liquidity and the incidence of these risks on a standalone basis across activities.**
- **Nature of stress testing:**
 - **Mostly on major line of businesses: corporate, retail, market.**
 - **Market risk was the most developed and consistent.**
 - **Credit stress tests were done on a particular portfolio, e.g. Home Equity or Auto Loans.**
 - **Some industry testing, e.g. Real Estate, Auto Industry.**
 - **Only one firm did enterprise-wide stress testing (limited).**
 - **Scenarios: Oil price crisis, Avian Flu pandemic, High Inflation, Housing bubble, Credit Crunch, Bond Market Collapse, Equity Collapse etc.**

2006 Horizontal Review

▪ Frequency of testing

- Only one institution conducted consolidated stress testing including credit, market and interest rate risk (2 times between 2004-2005).
- Three institutions performed market risk stress tests monthly.
- Credit risk stress tests were done on an ad hoc and periodic basis. One institution required each business to do stress tests annually. Industry wide stress tests were done as needed (e.g. deterioration of the Auto industry).

▪ Inter-relationship of Risks

- One firm performed periodic corporate stress test scenarios attempted to aggregate MTM stress loss estimates across risk types and different product exposures within major business lines. Scenarios covered the majority of trading portfolios, derivative counterparty exposures and investment bank credit exposures that could be MTM or modeled.
- Primary challenge was to identify plausible scenarios that could have a significant impact on the firm. Risk managers were hesitant to develop firm-wide models for scenarios that has very remote probabilities.
- There were also computational and system challenges.

2006 Horizontal Review

- **Aggregating of Risk**
 - One institution used a common metric (P&L impact) to aggregate exposures across product, business lines and countries.
 - Most market risk used aggregation of VaR numbers across products and business lines. Some used both worst losses and VaR numbers across all business lines.
 - Very little aggregation across risk types: credit, market, operational, liquidity etc.
- **Use of Stress Test Results**
 - Mostly used for reporting and/or initiate discussions of major risk concentrations with business heads and senior management.
 - Worst loss was a key input used to calculate economic capital.
 - Retail stress tests results were used to ensure the LOBs had adequately estimated ALLL reserves and to assess whether products were appropriately priced.

2006 Horizontal Review

▪ Some Interesting Scenarios

- Bank A's Housing Bubble Stress Test and Consumer Real Estate Portfolio Review did not result in material loss (e.g., worst stress loss of \$620MM).
- Bank B's Stress Test on Housing Bubble; single-family home price appreciation dropped by 1.2%.
- Bank C's Severe Housing bubble in CA and FL, mild bubble all others – Total \$251MM losses
- Homebuilding Overview: The most significant stress was noted in the strong downturn scenario, which was estimated at a 3% probability, a \$159MM stress loss.
- Bank A's Stress Test On Oil Price Shock: Oil prices between \$70-\$96. Net Credit Loss increased by \$67MM in the Cards, \$3.2MM in the Consumer Real Estate, and \$9.2MM in the Auto portfolios.
- Bank B's Oil Price ST, the worst scenario assumed a short term increase in oil prices to \$60 per barrel.
- Inflationary/ Higher Interest Rate Scenario: reflects higher oil prices, aggressive tightening of FR monetary policy, and slower economic growth. Results showed consumer credit card \$250MM and consumer real estate losses of 25MM.

2006 Horizontal Review

- **Summary Observations**

- **Business line and product-level stress testing regimes were reasonably well-developed.**
- **Market risk stress testing appeared to be the most developed.**
- **Corporate-wide credit risk stress testing was still at a developmental stage.**
- **Counterparty credit risk and Liquidity stress testing had significant limitations.**
- **No firm had a fully-developed program of integrated stress testing that captures all major financial risks on a firm-wide basis.**
- **Monthly stress testing performed on market risk with different scenarios, from moderate to severe, across business lines and products.**
- **Stress tests results were used to determine market risk capital.**

2007 Financial Market Turmoil

Senior Supervisors Group: Observations on Risk Management Practices during the Recent Market Turbulence

http://www.newyorkfed.org/newsevents/news/banking/2008/SSG_Risk_Mgt_doc_final.pdf

2007 Financial Market Turmoil - Senior Supervisors Group

- **Four firm-wide risk management practices that differentiated performance**
 - **Effective firm-wide risk identification and analysis**
 - **Consistent application of independent and rigorous valuation practices across the firm**
 - **Effective management of funding liquidity, capital and the balance sheet**
 - **Informative and responsive risk measurement and management reporting and practices**
 - **Stress tests were used to avoid concentration (e.g. funding concentration) and curb risk appetite (e.g. cross-currency exposures)**

2007 Financial Market Turmoil - Senior Supervisors Group

- **Range of risk measures and practices**
 - **Use of multiple tools**
 - **Design and integration of market risk measurement tools**
 - **Integration of exposures across risk types**
 - **Assessing for real life behaviors e.g. assume a four year life for a mortgage before repricing/exit**
 - **Identifying impact on earnings and capital**
 - **Scenarios developed using macro models, e.g. Moody's economy.com**
 - **Liquidity – stress funding gap limit and apply maximum projected overnight to one month funding requirement**
 - **Liquidity stress test scenarios included severe downgrade (4 notches), USD liquidity crisis and emerging market crisis.**
 - **Hedge Fund specific stress test**
 - **All hedged fund counterparties were exposed to an increased default risk by randomly simulating default across the portfolio.**

2007 Financial Market Turmoil - Senior Supervisors Group

- **Stress-testing & scenario analysis**

1. **Risk identification and modeling issues**

- Many firms expressed a desire to build a higher level of detail into their stress test models and systems.
- Some firms are revising their stress tests to reduce correlation benefits among exposures and are imposing larger credit spread shocks.

2. **Senior management involvement in stress testing and scenario analysis**

- Senior management involvement was particularly important in effectively using stress tests, and especially macro scenarios, as risk management tools.
- Less successful firms had difficulty getting senior management and business-line management to accept the results of forward-looking scenarios with large underlying price movements.

2007 Financial Market Turmoil - Senior Supervisors Group

- **Stress-testing & scenario analysis**

- 3. Links between scenarios and business practices**

- Several firms emphasized the need to improve the connection of forward-looking scenario analysis to the business practices of the firm.
 - Knowledge of how business areas made money helped risk managers identify relevant stress scenarios or provide warning when the assumptions underlying single-factor stress tests were inaccurate measures of risk.
 - System flexibility was cited as crucial, though some firms may not have had sufficiently flexible systems to handle customized scenarios and stress tests.

- 4. Accuracy of the Stress testing models**

- Several firms expressed their stress testing models underestimated the severity of the crisis
 - Reliance on underlying assumptions, ratings, proxies, correlation and hedges

2007 Financial Market Turmoil - Senior Supervisors Group

- **Observed weaknesses**

- **Firms that used single-factor stress tests calibrated to historical data significantly under-estimated the risk of super-senior subprime CDO positions (also structured products: ABS, RMBS)**
 - **The first problem is that the senior tranches were rated a “Aaa” credit risk despite the deteriorating credit standards at origination.**
 - **The second problem is that, based on this Aaa rating, some firms applied historical returns volatility associated with other “Aaa”-rated securities as a proxy for the price risk of senior subprime exposure even though these super-senior tranches represented new securities for which firms had little evidence of their historical performance.**
- **Several firms that experienced losses used VaR and static single factor stress tests calibrated using the same historical data series. As such, this provided no new information.**

2007 Financial Market Turmoil - Senior Supervisors Group

- **Observed weaknesses**

- **Many firms' stress measures did not properly capture the basis risk between cash bond and credit default swaps**
- **Some firms failed to capture syndicated loan pipelines and unfunded loan commitments in their firm-wide stress tests.**
- **Some firms used single-factor shocks calibrated to shorter holding periods than was revealed to be appropriate in light of the loss of market liquidity. At one firm the relatively short duration of the stress shock was based on an unrealistic assumption that positions could be managed down within that interval.**
- **Standard market risk stress tests did not adequately reflect reliance on liquid capital markets for managing, distributing and hedging risk (e.g. hedging strategies, valuation of complex products)**
- **The assessment of tail events, both qualitatively and quantitatively.**

2007 Financial Market Turmoil

- **Some lessons learnt**

- **Need buy-in from top people in the company**
- **Stress for liquidity and capital for off balance sheet Variable Interest Entities such as SIVs and Conduits**
- **Some firms failed to capture syndicated loan pipelines and unfunded loan commitments in their firm-wide stress tests.**
- **Link scenarios and business practices – compare stress results against risk limits to measure risk appetite**
- **Seek economist's help to create meaningful scenarios**
- **Prolonged stress periods require detailed assessments of second order effects**
- **Wider granularity is a better tool – build and understand scenarios**
- **Improve liquidity stress testing in a systemic crisis**
- **Flexible ad hoc scenarios to enable banks react promptly on new market conditions**
- **Nothing is impossible – AAA to worthless junk (i.e. consider the impossible)**

Update on the Current Financial Market Turmoil

- “Managers thought they were being bold in stress-testing their model against a percentage-point jump in rates, but didn't conceive of a sudden and nearly complete stop to interbank lending, a total absence of buyers for some securitized debt, and investors so panicked they're willing to accept negative interest rates to gain the safety of T-bills. In that world even GE Capital's business model doesn't work the way it's supposed to.”

.....Fortune, Oct. 10, 2008, “GE under Siege”



President's Working Group on Financial Markets Policy Statement on Financial Market Developments (03/2008)

The underlying causes of developing financial market turmoil...

Common themes were the failure of stress testing procedures to identify institutions' vulnerabilities to system-wide shocks to markets and market participants, and difficulties aggregating exposures across business lines and valuing instruments when markets became illiquid.

President's Working Group on Financial Markets

- **President's Working Group on Financial Markets: [Principals and Guidelines Regarding Private Pools of Capital \(02/2007\)](#)**

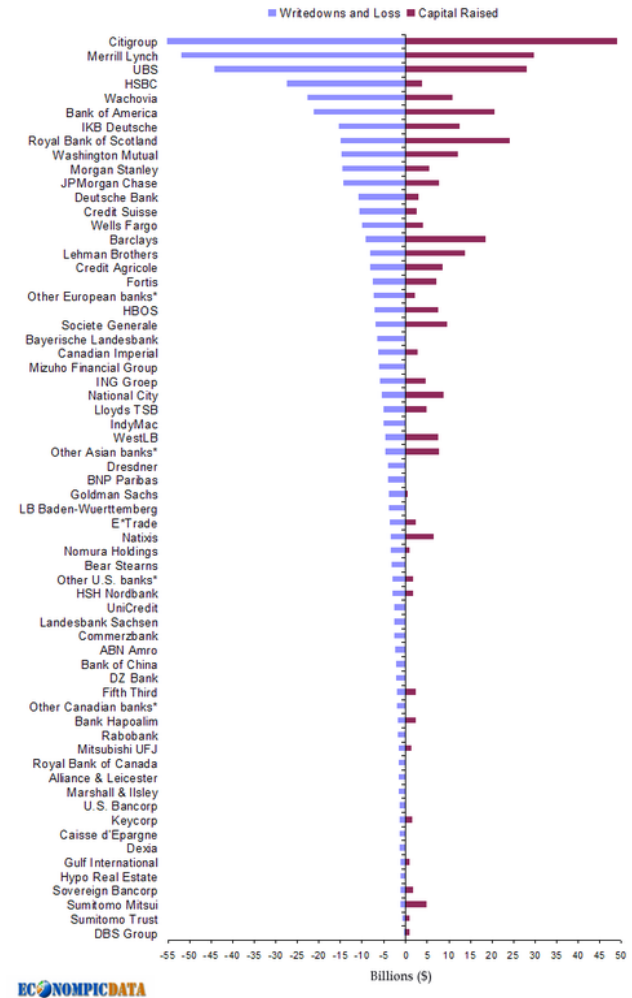
- 7. **Key creditors and counterparties must commit resources and maintain appropriate policies, procedures, and protocols to define, implement, and continually enhance best risk management practices.**

- 7.2 **Rigorous stress testing should be used to quantify the impact of adverse market events, both at the level of an individual counterparty and aggregated across counterparties. Stress tests should take into account potential adverse market liquidity events in which multiple market participants seek to unwind trades simultaneously.**

Current Regulatory Requirements for Stress Testing

<http://www.federalreserve.gov/BOARDDOCS/SRLetters/>

Writedowns, Losses, and Capital Raises to Date



Current regulatory requirements for stress testing

- **Market Risk Amendment (regulation – BIS, 11/2005)**
 - **Required for approval of the use of any internal model**
 - **Quantitative criteria require identification of plausible stress scenarios**
 - **Qualitative criteria emphasize that two major goals of stress testing are:**
 - **to evaluate the capacity of the bank's capital to absorb potentially large losses, and**
 - **to identify steps the bank can take to reduce its risk and conserve capital.**
 - **Results reviewed periodically by senior management and to have results reflected in the banks' policies and limits.**

Current supervisory expectations for stress testing

- **Regulatory guidance**
 - **Joint Policy Statement on Interest Rate Risk (SR96-13)**
 - **Sound Credit Risk Management and the Use of Internal Credit Risk Ratings at Large Banking Organizations (SR98-25: implicit)**
 - **Supervisory Guidance Regarding Counterparty Credit Risk Management (SR99-03)**
 - **Interagency Guidance on Country Risk Management (SR02-05)**
- **Common theme**
 - **Limited requirements explicitly in regulation**
 - **Considerable expectations stated in guidance**
 - **Banks have significant discretion with regard to specific design and implementation of their stress tests.**

Stress Testing in Basel II

- **US Final Rule - Section 22 (j) (6)**
 - The bank must periodically stress test its advanced systems. The stress testing must include a consideration of how economic cycles, especially downturns, affect risk-based capital requirements (including migration across rating grades and segments and the credit risk mitigation benefits of double default treatment).
- **BIS Part II – Paragraph 434**
 - An IRB bank must have in place sound stress testing processes for use in the assessment of capital adequacy. Stress testing must involve identifying possible events or future changes in economic conditions that could have unfavorable effects on a bank's credit exposures and assessment of the bank's ability to withstand such changes. Examples of scenarios that could be used are (i) economic or industry downturns; (ii) market-risk events; and (iii) liquidity conditions.

Expectations for stress-testing built into Basel II

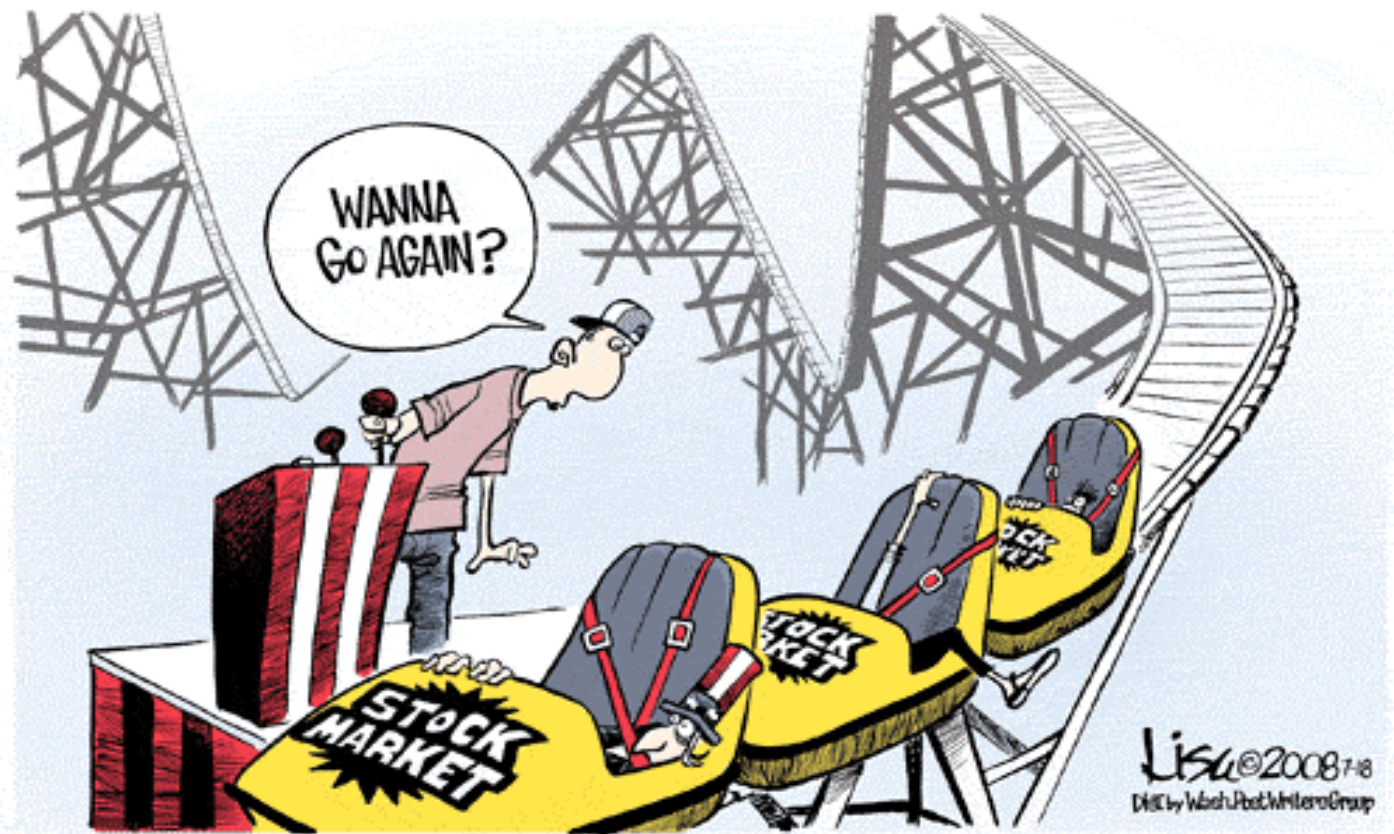
- **Pillar 1 (Final Rule, 12/07/2007)**
 - Stress tests required as means of understanding how economic cycles, especially downturns, affect risk-based capital requirements.
 - Remain at least adequately capitalized during all phases of an economic cycle.
 - Focus: minimum regulatory capital requirements
- **Pillar 2 (Supervisory Guidance, 07/31/2008)**
 - Stress testing is a critical component in the identification and measurement of material risks.
 - No prescriptive stress testing requirements.
 - Institutions should use stress testing to consider outcomes of severe events and use them as inputs to the capital assessment process.
 - Focus: overall capital needs of firm

Implementation of stress-testing in Basel II

- **Stresses on the PD and LGD parameters**
 - **PD: 10% increase in Card, 20% in Auto, 30% in Home products**
 - **LGD: < 25%, increase by 50%; 25% - 50%, increase by 25%;
> 50%, increase by 10%.**
- **Stress Testing Results (for illustration)**

| Retail Portfolios (as of 12/31/2007) | Baseline | PD increase | | LGD increase | | PD & LGD increase | |
|---|--------------|--------------|--------------|--------------|---------------|-------------------|---------------|
| | RWA | RWA | % change | RWA | % change | RWA | % change |
| Cards | 51.6 | 52.7 | 2.13% | 66.6 | 29.07% | 69.3 | 34.30% |
| Mortgage | 43.2 | 46.9 | 8.56% | 51.4 | 18.98% | 55.8 | 29.17% |
| Home Equity | 20.8 | 23.3 | 12.02% | 22.7 | 9.13% | 25.7 | 23.56% |
| Auto | 21.9 | 24.1 | 10.05% | 26.2 | 19.63% | 27.4 | 25.11% |
| Others | 24.5 | 26.4 | 7.76% | 28.7 | 17.14% | 30.2 | 23.27% |
| Total | 162.0 | 173.4 | 7.04% | 195.6 | 20.74% | 208.4 | 28.64% |

Best Practices



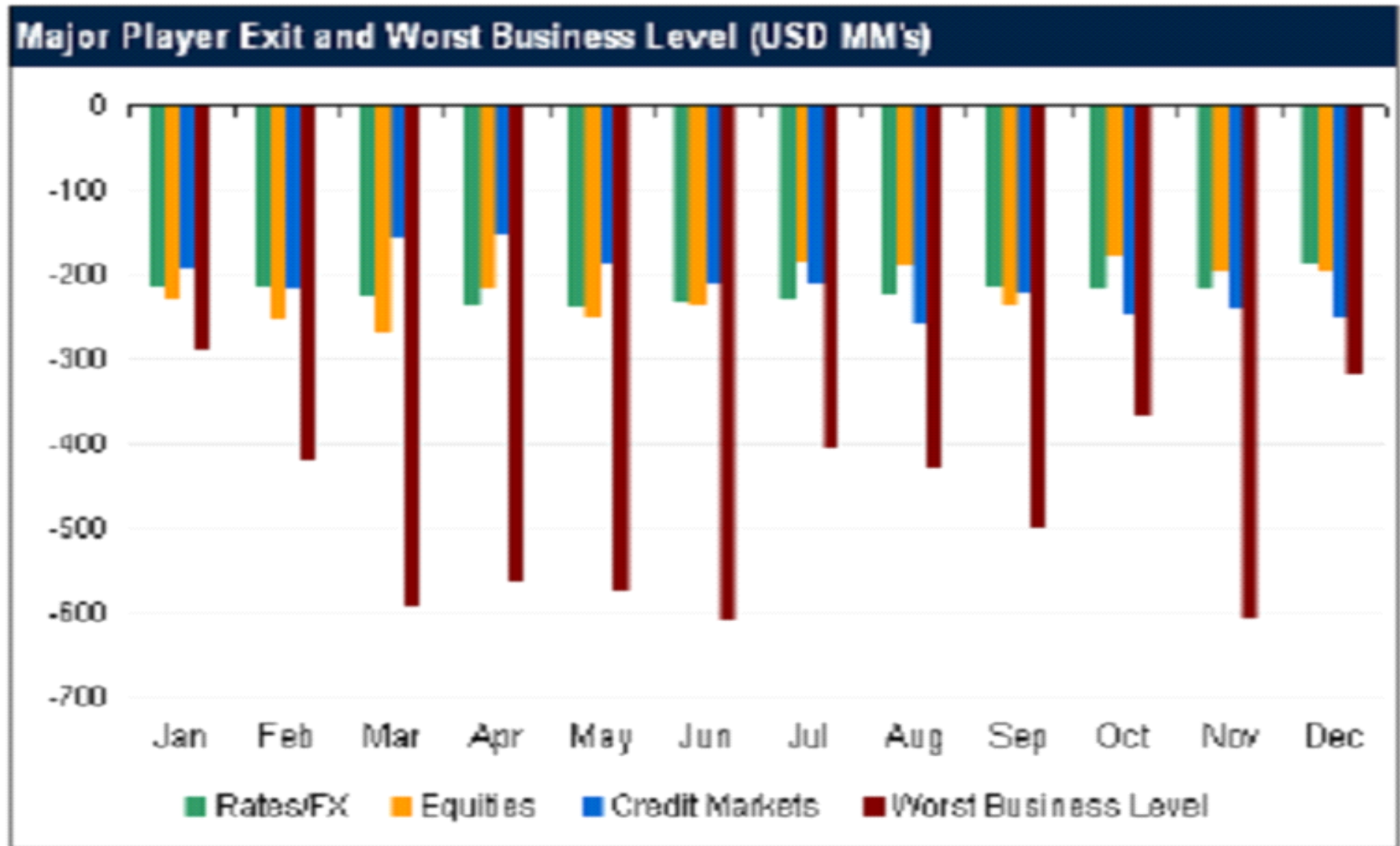
Source: cartoonbox.slate.com/

Best Practices – Making it counts

Market Risk Economic Capital = Function(Worst Stress Loss, VaR)

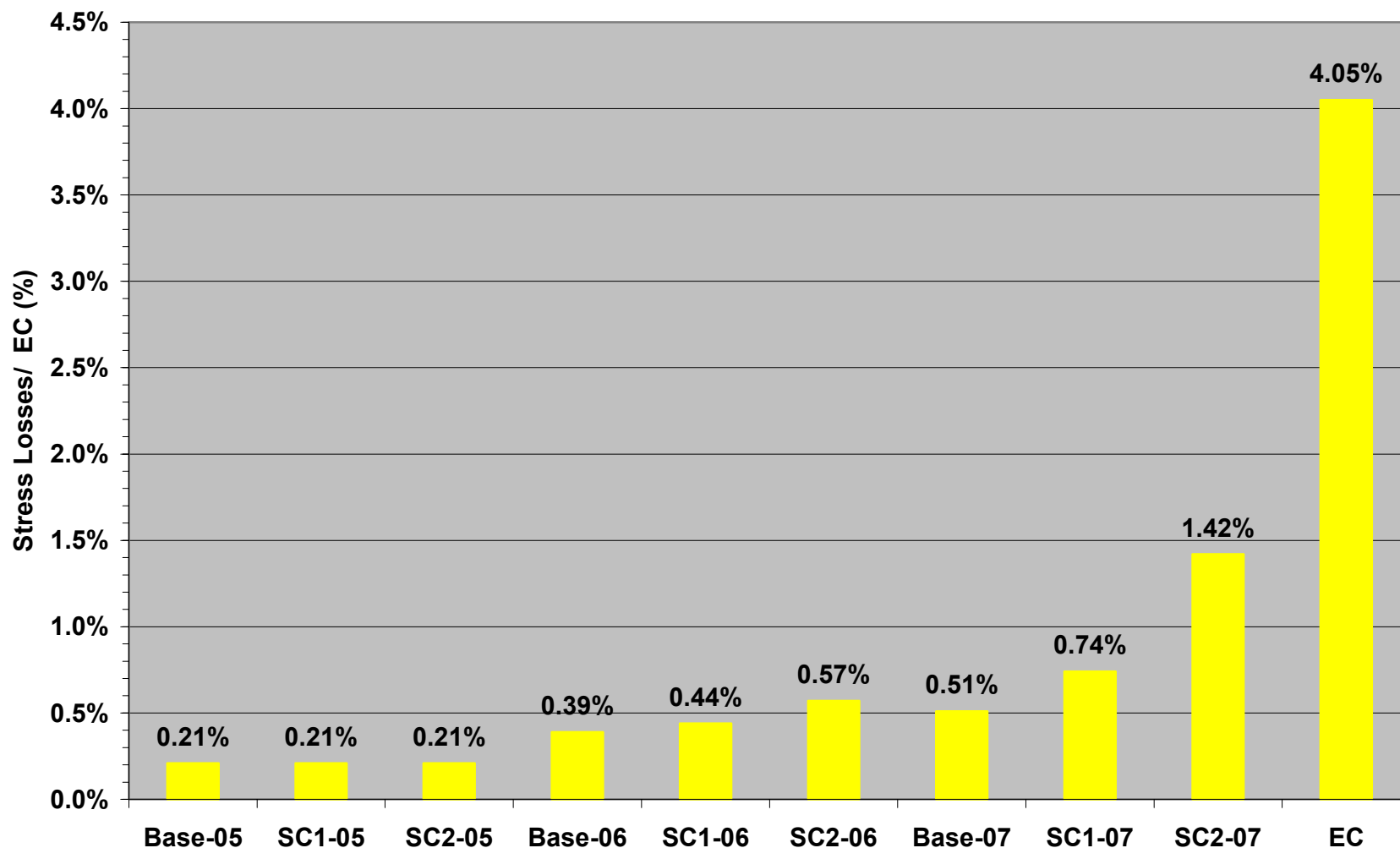
| | Stress_S1 | Stress_S2 | Stress_S3 | Worst ST (\$B) | VaR (\$MM) | Economic Capital (\$B) |
|--------|-----------|-----------|-----------|----------------|------------|------------------------|
| Jan-06 | 0.7 | 3.8 | 2.5 | 3.8 | 312 | 9.94 |
| Feb-06 | 1.9 | 3.3 | 2.5 | 3.3 | 318 | 8.70 |
| Mar-06 | 2.3 | 3.8 | 2.6 | 3.8 | 237 | 9.84 |
| Apr-06 | 1.7 | 3.2 | 1.9 | 3.2 | 244 | 8.35 |
| May-06 | 2.4 | 4.2 | 2.9 | 4.2 | 239 | 10.84 |
| Jun-06 | 1.9 | 3.7 | 2.5 | 3.7 | 221 | 9.57 |
| Jul-06 | 1.9 | 3.3 | 2.1 | 3.3 | 219 | 8.56 |
| Aug-06 | 1.7 | 3.8 | 2.8 | 3.8 | 227 | 9.82 |
| Sep-06 | 1.7 | 4.4 | 3.4 | 4.4 | 244 | 11.35 |
| Oct-06 | 1.7 | 4.6 | 3 | 4.6 | 224 | 11.82 |
| Nov-06 | 1.9 | 4.3 | 2.7 | 4.3 | 215 | 11.06 |
| Dec-06 | 2.5 | 4.4 | 3.1 | 4.4 | 288 | 11.41 |

Best Practices – Severity of scenarios



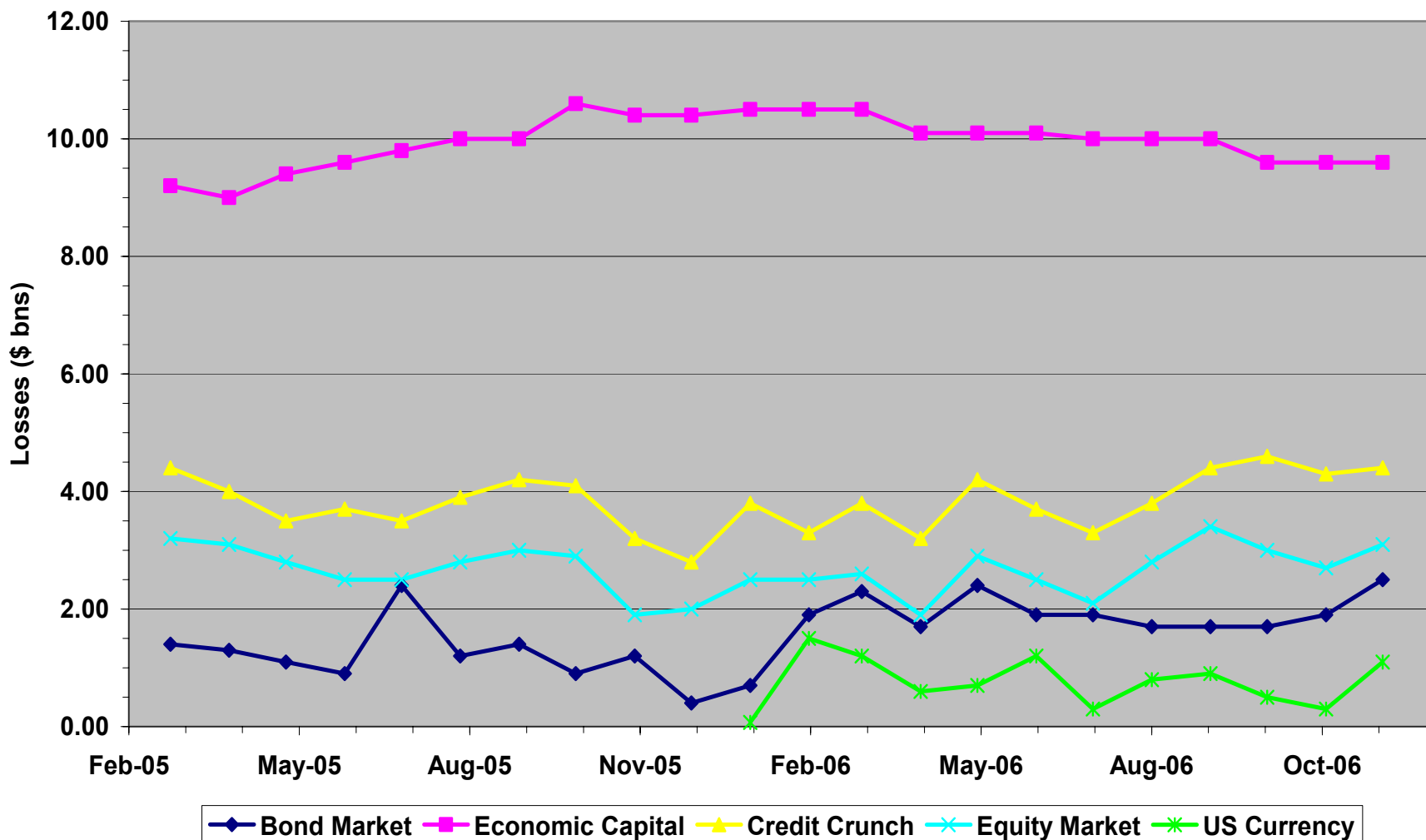
Best Practices – Comparing capital adequacy

Retail Mortgage - Stress Testing Losses and Economic Capital



Best Practices – Continue monitoring

Economic Capital Vs Stress Test Losses



Best Practices – Stress testing Economic Capital

Common Equity = \$132 bn

Common Equity + Reserves = \$145 bn

| Change in LGD | 1.0x | | | 1.25x | | | 1.5x | | |
|--|--------|--------------|--------------|--------|--------------|---------------|--------------|---------------|---------------|
| Change in PD | 1.0x | 1.5x | 2.0x | 1.0x | 1.5x | 2.0x | 1.0x | 1.5x | 2.0x |
| 1 x ρ (\$bn) | | | | | | | | | |
| Total Credit Risk Capital | 28.54 | 36.21 | 40.56 | 34.12 | 40.12 | 47.3 | 36.3 | 44.3 | 51.27 |
| Economic Capital | 118.47 | 126.87 | 131.75 | 124.89 | 129.11 | 135.81 | 124.9 | 133.97 | 138.02 |
| Deficit to EC (CE) | | | | | | -3.81 | | -1.97 | -6.02 |
| Deficit to EC (CE+R) | | | | | | | | | |
| 1.25 x ρ (\$bn) | | | | | | | | | |
| Total Credit Risk Capital | 37.05 | 45.46 | 52.06 | 41.08 | 50.73 | 59.49 | 46.32 | 56.91 | 63.89 |
| Economic Capital | 126.22 | 132.85 | 140.27 | 130.66 | 138.39 | 145.91 | 133.27 | 147.99 | 158.45 |
| Deficit to EC (CE) | | -0.85 | -8.27 | | -6.39 | -13.91 | -1.27 | -15.99 | -26.45 |
| Deficit to EC (CE+R) | | | | | | -0.91 | | -2.99 | -13.45 |

Best Practices – Consolidated Stress Testing Results

Template

| Date | | | All changes in value in \$mm | | | | | | | | | | | | | |
|--|--|--|------------------------------|----------|-------|-------|----------|--------------|----|--------|--------|--------|----------|-------|---|---|
| Type of Shock | Variable Shocked | Amount of Shock | Trading Book | | | | Subtotal | Banking Book | | | | | Subtotal | Total | | |
| | | | FICC | Equities | Munis | Other | | IB | CB | Retail | Non-US | Others | | | | |
| Market Factor Types | <input type="checkbox"/> IR (IR Level) | DM | + 200 bp | | | | | - | | | | | | - | - | |
| | | | - 200 bp | | | | | - | | | | | | - | - | |
| | <input type="checkbox"/> IR (10y-3 mo) (IR Slope) | EM | + 400 bp | | | | | - | | | | | | - | - | |
| | | | - 400 bp | | | | | - | | | | | | - | - | |
| | <input type="checkbox"/> Credit Spread | DM | + 100 bp | | | | | - | | | | | | - | - | |
| | | | - 200 bp | | | | | - | | | | | | - | - | |
| | | EM | + 100 bp | | | | | - | | | | | | - | - | |
| | | | - 200 bp | | | | | - | | | | | | - | - | |
| | <input type="checkbox"/> Spot FX curr vs. USD | DM | + 50% | | | | | - | | | | | | - | - | |
| | | | - 50% | | | | | - | | | | | | - | - | |
| | <input type="checkbox"/> Public Equity | EM | + 100% | | | | | - | | | | | | - | - | |
| | | | - 60% | | | | | - | | | | | | - | - | |
| | Apply 65-day stress shock | <input type="checkbox"/> Energy | (all) | + 20% | | | | | - | | | | | | - | - |
| | | | | - 20% | | | | | - | | | | | | - | - |
| | | <input type="checkbox"/> Public Equity | DM | + 40% | | | | | - | | | | | | - | - |
| | | | | - 40% | | | | | - | | | | | | - | - |
| | | EM | + 70% | | | | | - | | | | | | - | - | |
| | | | - 70% | | | | | - | | | | | | - | - | |
| <input type="checkbox"/> Other Comm'd's | | | + 100% | | | | | - | | | | | | - | - | |
| | | | - 100% | | | | | - | | | | | | - | - | |
| <input type="checkbox"/> Implied Vols | | | + 100% | | | | | - | | | | | | - | - | |
| | | | - 100% | | | | | - | | | | | | - | - | |
| <input type="checkbox"/> Prepayment error | | + 50% | | | | | - | | | | | | - | - | | |
| | | - 50% | | | | | - | | | | | | - | - | | |
| <input type="checkbox"/> ABX Index (and TABX) | | + 50% | | | | | - | | | | | | - | - | | |
| | | - 50% | | | | | - | | | | | | - | - | | |
| Macro-Economic Variables | <input type="checkbox"/> Unemployment (US BLS) | | + 2.0% | | | | | - | | | | | | - | - | |
| | | | - 2.0% | | | | | - | | | | | | - | - | |
| | <input type="checkbox"/> CSW (Case Shiller) | | + 10.0% | | | | | - | | | | | | - | - | |
| | | | - 10.0% | | | | | - | | | | | | - | - | |
| Historical Scenarios | 1987 Market Crash | | | | | | | - | | | | | | - | - | |
| | 2001 Recession | | | | | | | - | | | | | | - | - | |
| | 2007 Market Turmoil | | | | | | | | - | | | | | | - | - |

Best Practices – New ideas meeting new challenges

- **Reverse Stress Tests**

- **Counterparty Risk Management Policy Group III Report: The Road to Reform, 08/06/2008**
- **“The analysis starts with an assumption that over a short period of time an institution incurs a very large multi-billion dollar loss. The analysis would then work backward to identify how such a loss could occur given actual positions and exposures prevailing when the stress tests is conducted. If the assumed loss were truly large, it is highly likely that the possible sequence of events producing such a loss would have to entail elements of contagion or systemic forces. Thus, the reverse stress test is likely to require institutions to address issues that are not normally captured in stress tests.”**
- **Contemporary finance has become incredibly complex - The extent to which complexity feeds on itself thereby helping to create or magnify contagion risk “hot spots” that may have systematic implications.**

Recommendations



Industry Recommendations - IIF

- 1. Firms should develop internal management procedures that make stress testing part of management culture**
 - **Risk identification and control – bank-wide risk concentrations**
 - **Promote dialogue between business, senior management and risk function**
 - **Risk appetite**

- 2. Firms should ensure that their stress testing methodologies are consistently and comprehensively applied throughout the organization.**
 - **Use multiple risk factors, multiple business lines**
 - **Integrated with other risk management tools**

Industry Recommendations - IIF

3. **Stress testing methodologies should be actively used to complement and explicitly address the limitations of other risk management tools such as VaR.**
 - **Test the risk implications of scenarios on which limited historical data is available**

4. **Stress testing should include challenging scenarios.**
 - **Participation of senior management and business managers**
 - **Develop as conditions evolve**
 - **Balance of historical and forward looking scenarios**

5. **Stress testing policies should be designed so that the likelihood of severe events is not consistently underestimated.**
 - **Results should appropriately influence decision making**
 - **Ability to manage crisis should not be overestimated**

Industry Recommendations - IIF

6. **Stress testing methodologies should be firm-wide and comprehensive, covering balance sheet and off-balance assets, contingent and non-contingent risks.**
 - **Should include business cycle stresses as well as event-specific tail risks**

7. **Stress testing should take into account the risk of model error, and the uncertainties associated with models, valuations and concentration risks that may arise through the cycle.**
 - **Use to explore assumptions and identify limitations of models used for pricing and risk modeling**

Recommendations to Banks – Use, Governance

- 1. Stress testing should be an integral part of the overall risk management culture. Range of use includes**
 - **Risk identification and control – bank-wide risk concentrations**
 - **Liquidity management – assessing liquidity profile**
 - **Complementary (such as VaR, EC) and independent risk perspective**
 - **Capital management – integral part of ICAPP**
 - **Internal communication and decision making**
 - **External Communication – support regulatory capital**

- 2. Policies and procedures**
 - **Document internal policies and procedures detailing framework, purposes, assumptions, methodologies, scenarios, and remedial actions envisaged**

Recommendations to Banks – Use, Governance

3. Board and senior management involvement

- The board as the ultimate responsibility for the overall stress testing framework and its integration in bank's decision making.
- Senior management should use stress testing as a valuable tool to reveal vulnerabilities of the bank.

4. Link between scenarios and business practices

- Scenarios should reflect business practices and the materiality of business areas.
- Stress test results should impact bank's decision making.

5. Infrastructure

- Bank should invest in improving infrastructure such as system flexibility, appropriate granularity and the quality of the data.

Recommendations to Banks – Use, Governance

6. Maintenance

- **Bank should regularly maintain and update its stress testing framework.**

7. Validation

- **Stress testing framework should be regularly and independently validated (can be challenging)**
- **Verify assumptions, stress test results, meet purpose**

8. Risk coverage

- **Bank should examine the effect of shocks in all relevant risk factors, taking into account inter-relations between the risk factors and using a level of granularity appropriate to the purpose. The effectiveness of risk mitigation techniques should be systematically challenged.**

Recommendations to Banks - Coverage

9. Range of Scenarios

- Bank should cover a range of business levels, scenarios types, severity levels, time horizons and impact measures, depending on the use of the specific stress tests.

10. Forward looking approach

- Banks should include forward looking elements (hypothetical scenarios) into their stress testing in order to incorporate developing business conditions, emerging risk.

11. Contagion and feedback effects

- Banks should enhance stress testing techniques to better address system-wide, contagion and feedback effects.

12. Risk Concentrations

- Banks should use stress testing to identify, monitor and control risk concentrations.
- Firm wide – covering on and off-balance sheet assets

Recommendations to Banks – Specific Risks

13. **New products and business areas with rapid growth**
 - **Bank should aim to identify events or developments that would change their business strategy.**
14. **Complex and bespoke products such as securitized exposures**
 - **Banks should consider the characteristics of underlying assets, their exposures to systematic market factors implying strong correlations, relevant contractual arrangements and embedded triggers as well as leverage related to the subordination level in the issue structure.**
15. **Banks should include pipeline and warehousing risk in their stress testing regardless of their probability of being securitized.**
16. **Banks should integrate risks referring to off-balance sheet vehicles and related third party firms in their stress testing program. Scenarios should include assessing the size and stability of such vehicles and firms relative to their own financial, liquidity and regulatory capital positions.**

Recommendations to Banks – Specific Risks

17. **Bank should enhance their stress testing approaches with respect to highly leveraged counterparties in considering their vulnerability to specific asset categories or market movements and in assessing potential wrong way risk related to risk mitigating techniques.**
18. **The stress testing program should cover the impact of a reduction in market liquidity on exposure values and valuation approaches, in particular, for complex and bespoke exposures and products with thin, vulnerable markets.**
19. **Banks should aim to take account of simultaneous pressures in funding and asset markets by considering important interrelations between price shocks for specific asset categories, the drying up of corresponding asset liquidity, significant losses that can damage the bank's financial strength, growth of liquidity needs, or diminished access to secured or unsecured funding markets.**
20. **Banks should enhance their stress testing methodologies in order to capture the effects of reputational risk.**

Recommendations for Supervisors

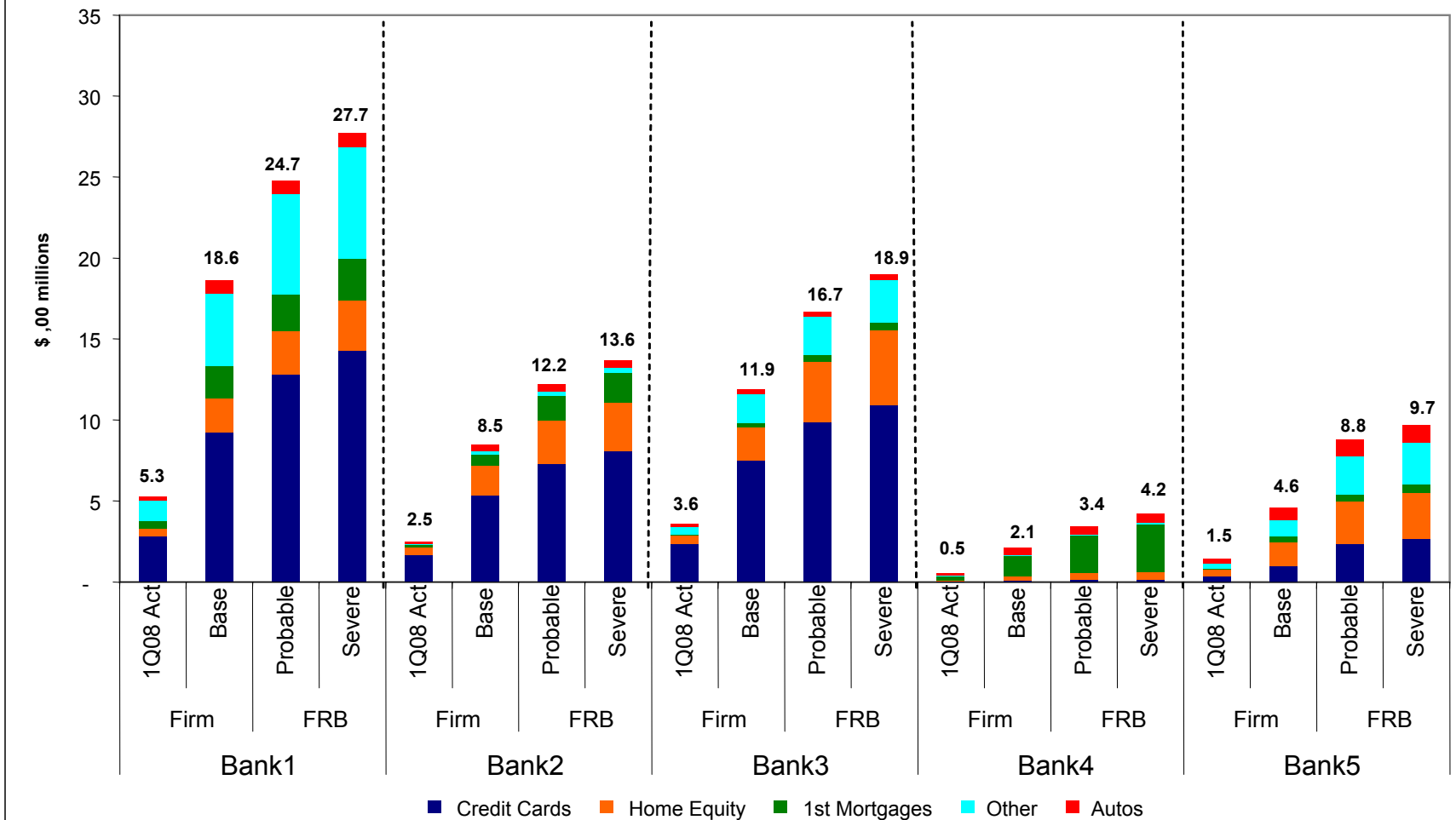
- 1. Supervisors should make regular and comprehensive assessments of banks' stress testing programs**
 - **Verify senior management involvement**
 - **Basel II Pillar 1 requirement**
 - **Integral part of the ICAAP process – capital management**
 - **Methodology – assumptions, risk factors, models**
 - **Firm wide stress test results**
 - **External Communication – support regulatory capital**
- 2. Supervisors should require management to take action if material deficiencies are identified in its stress testing program**
- 3. Supervisors should make use of a bank's stress testing results when evaluating a bank's capital adequacy and calculating capital buffers**

Recommendations for Supervisors

4. **Supervisors should consider implementing stress test exercises across different institutions**
 - **Common scenarios**
 - **Risk type, portfolio (e.g. liquidity, credit losses)**
 - **Firm wide (weakest link)**
 - **Capital adequacy (systemic vulnerabilities)**

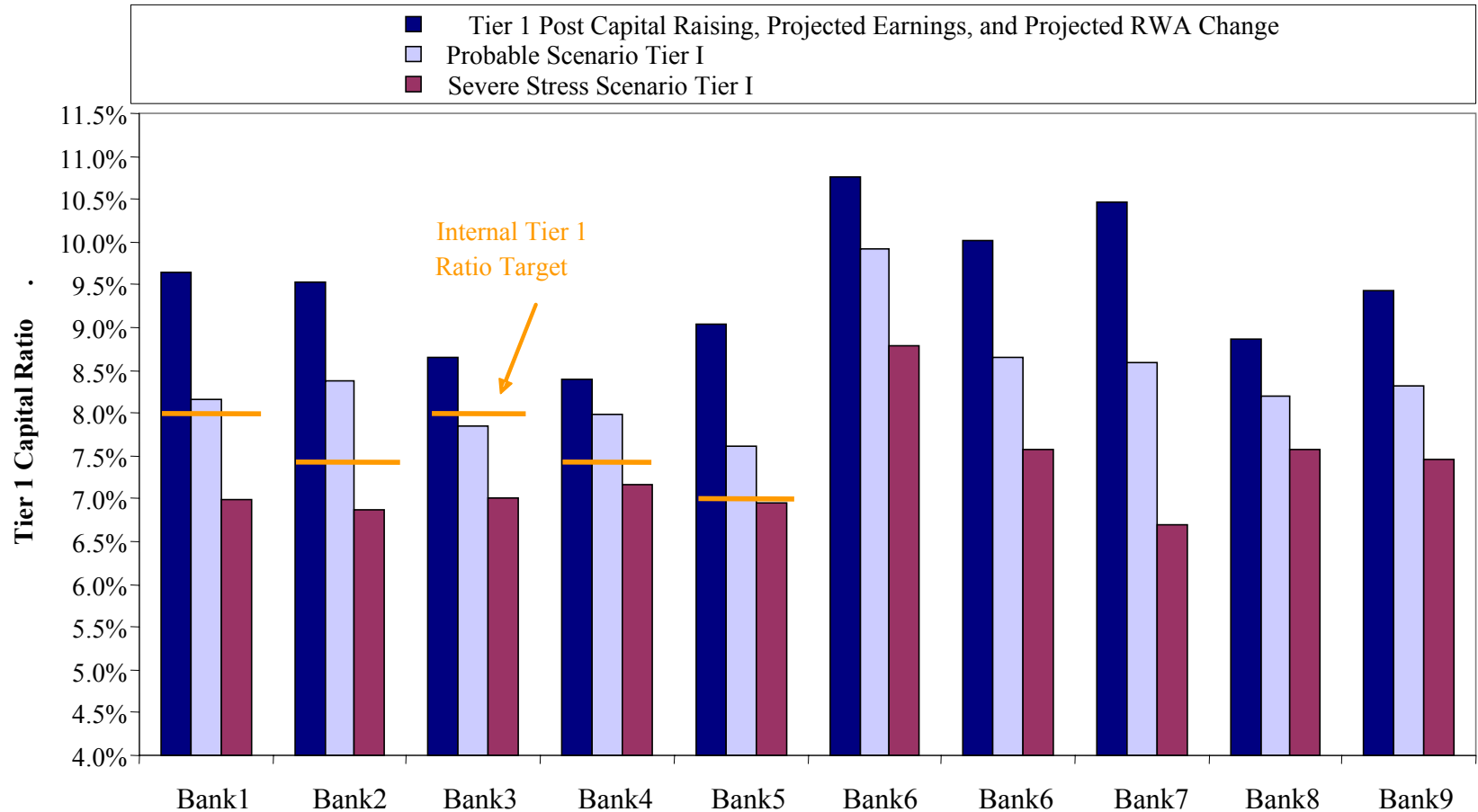
Stress Test from Supervisors

Consumer Stressed Losses vs. Firms' Forecast – 4Q 2008
 (numbers are for illustration purpose only)

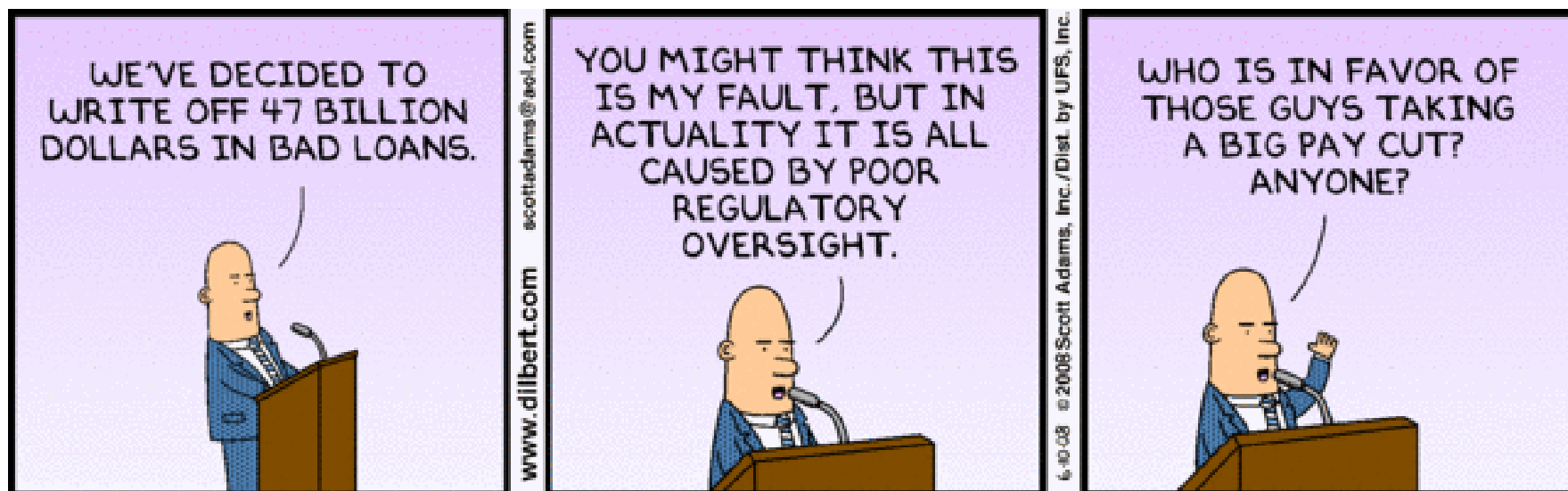


Stress Test from Supervisors

Institutions' Tier I Capital Ratios & Potential Stressed Losses (For illustration purpose only)



Conclusions



June 10, 2008 www.dilbert.com

Conclusions

- **Stress testing is not a regulatory exercise, is also not a magical potion. It is an effective risk management tool if senior management is involved and appropriate resources are allocated.**
- **Enhance stress testing methodologies**
- **Review articles that are cited in this presentation.**
- **Look for upcoming Stress Testing papers in BIS website**
- **Understand 2007 financial market turmoil**
 - **Triple-A Failure, The New York Times, April 27, 2008**
- **Jeremy Siegel (WSJ, 09/18/2008) – The Resilience of American Finance**
 - **John Maynard Keynes, “It is much easier for a man to fail conventionally than to stand against the crowd and speak the truth”.**
- **Ben Bernanke (10/15/2008) – Stabilizing the Financial Markets and the Economies**
www.federalreserve.gov/newsevents/speech/bernanke20081015a.htm

Beyond Stress Testing

