Stress Testing

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World Bank/International Monetary Fund/Federal Reserve System Seminar for Senior Bank Supervisors from Emerging Economies

Washington, DC, October 20, 2011
Introduction: Increasing Importance and Typology of Stress Testing

**BU: Bottom up**
- Implemented by individual institutions, using internal data (and possibly model).

**TD: Top-down**
- Implemented by authority/IMF, using supervisory or published data.

- **Microprudential/supervisory (individual institution focused)**
  - Internal risk management
  - Supervision (Basel Pillar 2, Solvency II)

- **Macroprudential/surveillance (system-focused)**
  - IMF Financial Sector Assessment Program (FSAP)
  - Central banks, supervisory agencies (Financial Stability Reports)

- **Crisis management tool**
  - Recent examples (United States, Europe)
Part I: Stress Test—Overview and Examples
Stress Test: General Objective

What ST can and should do?

- ST supplements other risk management tools
- Provides forward-looking assessment of risks
- Facilitates development of mitigation/contingency plans (micro and macro prudential policy)

BCBS Principles for Sound ST Practices & Supervision

**Banks: 15 principles**
- Use of ST and integration in risk governance
- ST methodology and scenario selection
- Specific areas of focus
  - risk mitigation techniques,
  - complex products,
  - pipeline and warehousing risks,
  - reputational risk,
  - leveraged counterparties

**Supervisors: 6 principles**
- regular ST,
- corrective action,
- assessment of scope/severity,
- Pillar 2,
- common scenarios,
- systemic vulnerabilities
Stress Test: Integrated use of various types of stress testing

**Setting stress testing policy**
- Firms’ own stress testing
  - Firm’s own assumptions, possibly reverse ST
  - Assess stressed capital and/or liquidity positions

**Setting scenarios**
- Supervisory stress testing
  - Test specific firms with coordinated or firm specific assumptions
  - Assessment against minimum specified capital and liquidity requirements

**Monitoring and aggregation**
- System-wide stress testing
  - Simultaneous test with the same assumptions
  - System-wise indicators, with some information on distribution

**Policy Objectives**

**Cross check**

Micro-prudential analysis  
Macro-prudential analysis
Stress Tests for Pillar 2 Capital Planning

- ST results size “capital planning buffer”
  - Additional capital (pillar 2) held above minimum requirements to absorb losses in adverse circumstances
  - Specific example UK FSA definition:
    “…the amount of capital that should be held now, so that it is available to absorb losses and meet higher capital requirements during adverse external circumstances after allowing for realistic management actions.”

Guidance: Assumptions for Pillar 2 ST

- Supervisory agencies often publish an common (macro) scenario against which firms can benchmark severity of own scenario

When firms choose scenarios…
- Scenarios firms should consider
  - a severe downturn scenario
  - forward-looking hypothetical events
  - experienced over a long historical period.
  - calibrated against the most adverse movements in individual risk drivers
Stress Tests in FSAPs

Risk assessment including stress tests

Stability module

Usually a combination of top-down and bottom-up approaches

Crisis management and resolution

Financial stability policy framework
## Stress Tests in FSAPs: Risk Assessment Matrix

<table>
<thead>
<tr>
<th>Country X</th>
<th>Overall Level of Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Threats</strong></td>
<td>Likelihood of severe realization of threat in the next 3 years</td>
</tr>
<tr>
<td>Threat #1</td>
<td>High</td>
</tr>
<tr>
<td>Threat #2</td>
<td>Low</td>
</tr>
<tr>
<td>Threat #n</td>
<td>Medium</td>
</tr>
</tbody>
</table>
Stress Tests in FSAPs

Source: FSSAs.
Stress Tests in FSAPs: selected tools

Introduction to applied ST

- Streamlined exercise based on FSAP tests in smaller/less complex systems (“ST 101”)
- Suited for systems under BI, BII standardized approach
- Example with fictional FSAP-like data (“Bankistan”)

Next generation ST

- Incorporate various additional features suited for more complex systems
- Suited for systems under Basel II (advanced approach)
- Incorporate new issues
  - Upgraded liquidity ST framework
  - Linkage between solvency and liquidity stress


Stress test and Central Banks

- Number of CBs publishing ST results
A tale of how an inadequately designed stress test could give false sense of security

CASE STUDY — ICELAND
Case Study: Iceland

- Banking sector: 900% of GDP in ‘08.

- Financial Supervisory Authority (FME) regularly performed and published ST of Iceland’s banks.

- Landsbanki Islands: the country’s 2nd largest bank, assets of 235% of GDP.
  - October 7, 2008: nationalized, receivership.

The largest banking crisis (relative to GDP) in modern history (so far)!
Case Study: Iceland

Parameters applied by FME in the 2007 ST:

- 35% fall in domestic stocks, 25% fall in foreign stocks
- 20% loss in value of loans and appropriated assets
- 7% fall in bond prices
- 20% depreciation of ISK
- Focus on solvency test

Results

- CAR = 10.5% (from 11.7%)
- Tier 1 ratio = 8.8% (from 10.1%)

Actual shocks:

- 25%–50% fall in equity portfolios
- NPL ratio jumped from near 0% to 40+%
- 700 bps increase in bond portfolio yields. (implying 40+% fall in bond prices)
- 35%–55% depreciation of ISK
- 40% deposit run from U.K. Icesave accounts

Consequence

Biggest crisis in the history (relative to GDP)
Case Study: Iceland

**Limited coverage of risks**
- Focus on solvency issues (credit and market risks)
- Missing liquidity risk (deposits are considered stable)

**Incomplete use of available data**
- Focus on P&L and BS data
- Not using off-BS data
- Notes to financial statements

**Did not “think the unthinkable”**
- Actual shocks were
  - Large and materialized fast
  - Global rather than domestic
  - Deposit run

**Minor ST results**
## Case Study: Iceland Summary of Results

<table>
<thead>
<tr>
<th>LANDSBANKI: SUMMARY OF LIQUIDITY STRESS TEST OUTCOME (UP TO 12 MONTHS)</th>
<th>ISK millions</th>
<th>USD millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland GDP (4 quarters to 30 September 2008)</td>
<td>1,400,452</td>
<td>14,500</td>
</tr>
<tr>
<td>Liquidity shortage at Landsbanki after shocks as at 7 October 2008</td>
<td>-733,722</td>
<td>-7,597</td>
</tr>
<tr>
<td>Liquidity shortage after shocks as percentage of GDP</td>
<td></td>
<td>52.4</td>
</tr>
<tr>
<td>Liquidity shortage (liquid assets only) after shocks</td>
<td>-1,703,941</td>
<td>-17,643</td>
</tr>
<tr>
<td>Liquidity shortage (liquid assets only) after shocks as percentage of GDP</td>
<td></td>
<td>121.7</td>
</tr>
</tbody>
</table>

*Ong and Cihak (2010), IMF WP 10/156*
ST IN CRISIS MANAGEMENT

US: Example of successful ST
Europe: Example of mixed success ST
ST in Crisis Management: United States

**Supervisory Capital Assessment Program (SCAP)**
- ST: part of supervisory process
- 2009 exercise, unprecedented scale
- Examine 19 largest BHCs (assets > US$100 bn) simultaneously
- 2/3 of the U.S market

**SCAP results (May 2009):**
- 10 participating BHCs require injections (total=US$185 billion)
- Based on “high-quality” capital that can absorb losses

**Participating banks able to take action to improve capital**
- Tier 1 common equity up by US$77 bn by Nov. 2009
- Only one institution required an additional public capital injection

**Bolstered confidence in a period of heightened uncertainty**

Goal: reduce more adverse outcome in markets
ST in Crisis Management: United States

SCAP, considered as a success

- Calmed down markets, confidence regained
- Helped improve funding environment
  - After detailed dissemination of bank-by-bank results, BHCs raised $57 billion in private capital
  - 12 of participating BHCs fully redeemed their preferred shares under CPP; 5 announced/took steps to do so soon

Keys for a successful ST

- Disclosure around the exercise
  - Detailed information on supervisory goal, approach, assumptions and methods
  - Detailed firm specific results
- Aggregate estimates seen as credible
  - Consistent with many external estimates
  - Plausible upper-bound on size of the problem and potential government actions
- Clear cross-sectional comparison and variation
- Actions following the exercise
  - Capital raising plan (with government backstop)
ST in Crisis Management: Europe

2010 European (EU) ST

- Major undertaking (scope)
- Publication of (individual) results, including detailed exposure data for high-risk sovereigns
- Improving transparency of the financial position of EU financial institutions
- Announcement of actions to address bank capital
- Complemented by other measures
  - Establishment of the European Financial Stability Facility (EFSF)
  - Improvements in EU’s financial supervisory framework

Results and criticism

- 7 out of 91 banks with Tier 1 CAR < 6%, total recap need €3.5 bn
- 5 of 7 are in Spain, the rest is one Greek and one German

Overall, positive market reaction with some reservation

- Pros:
  - Disclosure of detailed sovereign exposures,
  - Robust loan-loss assumptions for many banks,
  - No unexpected failures

- Cons:
  - Low hurdle rate
  - Sovereign shock applies only to trading book and not MTM securities
  - Optimistic earning and loan-loss rate assumptions for some banks
Summary: ST as Crisis Management Tool

- Can clarify financial institutions’ health
  - … if the exercise is credible and transparent
- Can improve confidence
  - … if accompanied by a credible follow up plan
  - needs a good PR strategy
- Issues
  - How stressful? (Credible, but not pro-cyclical)
  - Publish or not? (If so, how much detail?)
  - If mishandled, it could backfire
  - How to reflect contagion risk?
Part II: Stress Tests—Challenges and Further Work
Stress Testing: Challenges

**Review of ST practices**
- Central banks’ financial stability reports (IMF WP 06/163)
- Surveys of ST practices in major banks (BIS)

**Main messages**
*ST useful, but need more*
- Discussion of limitations implied by data, methodology (“health warnings”)
- Discussion on shocks being analyzed (no “black box”)
- Integration with other indicators and tools
- Comparable approaches in peer groups of countries
ST Challenges: Calculated Impacts vs. Reality

Capital injections needed under the worst ST scenario (% GDP)

Fiscal support to the financial sector in the country (as of April 2009)

Note: data for European country FSAPs.
ST Challenges: Assumptions vs. Reality

- Assumed depreciation/devaluation (%)
- Actual depreciation/devaluation (%)

Graphs showing the distribution of assumed and actual depreciation/devaluation in various percentage ranges.
Issue #1: ST Preconditions

**Issues**

- Quality of input data
  - ST only as good as input data
  - Data sometimes simply missing or not used
  - ST depend on underlying assumptions

- Scope of the exercise
  - E.g.: off-balance sheet items, “shadow” banking, data on liquidity/funding exposures

**Progress so far**

- Tools to assess data quality
- More caveats about data Q in recent ST
- Nonbank FIs increasingly included in ST

**Further steps**

- More emphasis on data quality and assumptions
- Not conducting ST should always be an option
- Better integrate ST and other tools/indicators
- Extend scope in some cases
Issue #2: Scenario Design

What is “exceptional but plausible”?
- Insufficient explanation of size of the shocks
- Often no link to macro economy

Combining shocks in consistent way
- A challenge given that models break in crises

Myopia/limited imagination
- Long time since last crisis; inhibitions to “think the unthinkable”

Political economy considerations
- Policy makers prefer to say “financial system is resilient”
- Risk of ST being perceived as assessment of policy makers
- Self-fulfilling prophecy

Challenges with good scenario design
Issue #2: Scenario Design: FSAP

Progress so far

- More emphasis on macro scenarios
- More emphasis on explaining shock sizes
- Longer horizons in assessing shock impact
- More likely to discuss sensitive shocks

Further steps

- More severe shocks
- Threshold approach (reverse ST)
- Focus more on relative impacts, evolution over time
- Scope for more standardization, if not uniformity
Issue #3: Methodology

Areas needing for improvements

- Liquidity ST
- Full distribution of losses in a scenario
- Non linearity
- Structural breaks
- Correlation across portfolios
- Contagion
- Feedback effects
Issue #3: Methodology in FSAP

- Feedback effects
- Liquidity ST
- Full distribution of losses in a scenario
- Non linearity
- Structural breaks
- Correlation across portfolios
- Contagion
- Systemic risk models
- Interbank contagion more common
- Scenario analysis linking credit risk to macro is more common
- More involvement of authorities and financial institutions

Progress so far
Issue #3: Methodology in FSAP

- More work needed: second round effects
- More work needed: cross border transmission
- More work needed: better modeling of reaction function by institutions
- More work needed: joint analysis of market, credit, liquidity risk
- More work needed: full distribution of losses in a scenario
- More work needed: nonlinearity
- More work needed: structural breaks
- More work needed: contagion
- Areas needing further steps

Liquidity ST
Feedback effects
Correlation across portfolios
Structural breaks
Non linearity
Contagion
More work needed
Systemic Risk Models

Balance sheet based approach

- Network analysis of contagion using interbank exposures (interconnectedness)
- ... extensive data need constraints new development

Market price based approach

- Systemic CCA
- Distress dependence
- Conditional Value at Risk (CoVaR)
- Systemic expected shortfall
- Distress insurance premium
- ...

... extensive data need constraints new development
U.S. FSAP Stress Tests

IMF’s FSAP assessment for U.S. completed in mid-2010

Praised the SCAP

Illustrated that calculated losses are much higher if the potential for spillovers among institutions is reflected

“Three pillar” approach*

• Pillar 1: SCAP-like exercise
• Pillar 2: Macro-financial Stress Testing with Distress Dependence
• Pillar 3: Systemic Contingent Claims Analysis (CCA)

* Note: this is different from the Basel II “pillars”.
U.S. FSAP Stress Tests—”Pillar II”

Macroeconomic Scenario Engine: IMF RES

Macroeconomic Factors

Financial Factors

Bank 1..n PoD

Insurance PoD

GSE PoD

CIMDO Financial System Multivariate Density

LGDs

Exposures

Simulation

Marginal Contribution to Systemic Risk

Financial System’s Loss Distribution

Financial Stability Measures
U.S. FSAP: Differences in Loss Measurements

Expected Loss (EL) – "regulatory capital"

Unexpected Loss (UL) – "economic capital"

VaR95%

Mean

Probability

Pillar 1

Pillar 2

VaR99%

Pillar 3

ES95%

average density beyond VaR95%

Aggregate (Portfolio) Losses

"tail risk"
Conclusion

ST a useful macroprudential tool, but …
• Some did not capture relevant risks
• Often captured right risks, but relatively small impacts
• Many just confirmed issues visible otherwise

ST useful as crisis management tool, but …
• Needs to be done credibly (relevant scenarios, candid interpretation, high-quality capital, credible government intervention if needed)
• No substitute for regular ST

Issues

• ST preconditions (data, coverage, assumptions)
• Scenario design (“extreme but plausible”)
• Methodology (liquidity ST; loss distribution, contagion, feedbacks, nonlinearities)
Thank you!

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