Effective Techniques for Stress Testing and Scenario Analysis

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Effective Techniques for Stress Testing and Scenario Analysis

Agenda

1. What is stress testing?
2. Stress testing methodologies
3. Developing an effective stress test program
5. Regulatory expectations
6. Best practices
7. Challenges ahead
Stress testing is a risk management tool used to simulate an extreme but plausible event (s) and measure how the event (s) would impact firm’s income.

• Non-statistical tool which is used by firms to measure potential loss to a set of worst-case “what-if” scenarios

• Each scenario involves defining a set of risk factors and amounts by which these factors could move (in a stressed market) under a specified scenario

• The impact of each scenario is measured by applying a scenario to the trading and/or accrual positions and calculating potential loss to the firm. The worst-case loss from these scenarios is reported as the “Stress Loss” to the management
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1.1 What is stress testing?

Helps management in addressing key risk issues

- What is the P&L impact of a specific stress scenario?
- What is the worst-case scenario and associated loss?
- What is the level of concentration risk (exposure to an industry or geographic region) or to a specific name?
- What is the risk appetite of the firm i.e. what is the level of loss the firm is willing to take under stressed markets?
- Risk control - what action can management take to bring the exposure within ‘acceptable’ level?
• Stress testing is needed to complement VaR
  – VaR does not offer information on the direction of exposure
  – VaR does not quantify potential magnitude of losses if and when actual loss exceeds VaR
  – VaR is measure of risk in normal markets i.e. ignores stress events (falling in tail region beyond the specified confidence interval)
  – VaR implementation may use simplifying assumptions (e.g. correlation) that may be violated under stressful conditions
  – Stress conditions in markets may last longer than the holding period assumed in VaR calculation
1.2 Why stress testing?

Required by regulators

“Banks that use the internal models approach for meeting market risk capital requirements must have in place a rigorous and comprehensive stress testing program ... Banks should have information on the largest losses experienced during the reporting period available for supervisory review ... The results should be reviewed periodically by senior management ... the national authorities would expect the bank to take prompt steps to manage those risks appropriately.”

- 1996 Amendment to the Basel Capital Accord
2. Stress testing methodologies

Three methodologies are in use

- Sensitivity analysis
- Historical scenarios
- Hypothetical scenarios

Other methodologies

- Extreme value theory (history of past stress events is used to determine frequency and severity of future stress events)
- Stressed VaR
2.1 Stress testing methodologies
Sensitivity analysis

Examples of sensitivity analysis
- Parallel yield curve shifts (e.g. +/- 100 bps)
- Volatility changes
- Prepayments levels changing
- Credit spread tightening/widening
- Currency devaluations
Sensitivity analysis is

- Relatively simple and easy to implement
- Calculates the impact of a large predefined shock in a specific risk factor(s)
- Mostly done using the Deltas (sometimes full revaluation may also be used)
- It is critical that the amount of stress shock used for each risk factor is extreme but plausible
- Largest change may not always be the best
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2.1 Stress testing methodologies
Sensitivity analysis

Pros:
• Useful tool for identifying major risks in the books
• Trader/management friendly. Can be used easily by traders or management for reducing risks

Cons:
• Each risk factor is considered in isolation. The results does not give a reliable estimate of the worst-case loss
• The likelihood of the risk factor going through a large change is not clear (i.e. there is no probability assigned to the outcome)
Examples of historical scenarios

- 1987 Stock Market Crash: From Oct 13 to Oct 19, Dow falls 31%, Total market capital lost – $1 trillion
- 1994 Bond Market Crash: FED raises rates by approx. 250 basis points (against market expectations)
- July 2, 1997 Asian Crisis: Bank of Thailand abandons Baht’s peg to the Dollar and currency falls 18%. By year end, South Korean Won falls 47.5% and Indonesian Rupiah falls 56%
- September 23, 1998 FED orchestrates a $3.5 billion bailout for LTCM, the hedge fund. All major banks lose significant amount of money
2.2 Stress testing methodologies
Historical scenario analysis

Historical scenario analysis

• Based on actual historical events to identify changes in risk factors
• Informs the risk manager as to how the books would have performed under extreme moves in risk factors which actually did occur in the past
• Current risk factors may be scaled to reflect relative price changes experienced during the historical event
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2.2 Stress testing methodologies

Historical scenario analysis

Challenges

• Which scenario to use?

• What is the most relevant period to use (i.e. start and end dates)?

• Whether to use absolute or relative (i.e. percentage) changes in risk factors?

• Relationship between market risk factors and regime changes (i.e. liquidity or correlations)
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2.2 Stress testing methodologies
Historical scenario analysis

Pros

• Easy to understand, objective and transparent

• Interpretation of results is easy because no one can question the likelihood of the stress event used

• Easy to aggregate across portfolios if the shocks used in the scenarios are all from the same historical event

Cons

• Hard to justify that the event chosen could repeat again

• Difficult to apply to new products (lack of historical data)

• Economic conditions leading to the historical event may no longer be relevant in today’s market
2.3 Stress testing methodologies
Hypothetical scenario analysis

Examples of hypothetical scenarios
• Economy’s condition – e.g. recession
• Very high oil prices ($200)
• War
• Political Events
• Bird Flu Pandemic
2.3 Stress testing methodologies
Hypothetical scenario analysis

Challenges

- Choice of scenarios is critical
- Shocks used should be extreme yet plausible
- Include impact of market illiquidity in the stress scenario
- Important to include possibility of regime shifts in terms of correlation or vols
- Key element here is assumed duration of the shock
- The changes in various risk factors should be consistent and reasonable
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### 2.3 Stress testing methodologies

#### Hypothetical scenario analysis

**Pros**

- Useful for understanding the P&L impact when markets change unexpectedly
- Designed to include future extreme market moves keeping current market environment in mind
- Scenarios used are not constrained by history and can be tailored to portfolio risk characteristics

**Cons**

- Subjective in nature, difficult to get management ‘buy-in’
- Unlike VaR, no probability can be assigned to a selected scenario
3. Developing an effective stress testing program

Issues to consider

- Large number of choices regarding scenarios, risk factors to stress, how risk factors are combined, range of shock to be considered and choice of timeframe
- Predicting stress events is hard and yet choosing the ‘right’ scenario is very important
- Use relevant scenarios for your business which can pass the ‘reality check’
- For complex products it is difficult to identify set of risk factors and amount by which to shock (lack of data)
- Assumptions and weaknesses should be transparent
3.1 Developing an effective stress testing program

Issues to consider (contd.)

• Involve the right kind of people (trading, risk management) in the design and implementation phase. Obtain early ‘buy-in’ from the management

• Effectiveness of stress tests is critically dependent on skills, intuition and experience of developers

• Report details (granularity) should be based on the needs of the user (desk/business head vs. CRO)

• Ensure that the systems are robust and flexible to support both current and future scenarios

• Computational costs involved
3.2 Developing an effective Stress testing program

Technical considerations

- Methodology used - Historical, Hypothetical or Sensitivity
- Holding period assumptions (1 day/1 week/1 month)
- Pricing models (Full Revaluation, Grid-based, Taylor series)
- Frequency of stress testing (Daily/monthly)
- Breadth of risk factors (several hundreds to several thousand) and proxies used
- Asset liquidity/correlation assumptions
- Policy issues (approval/review of scenarios, risk limits and responsibilities)

Number of Stress Tests by Asset Type

- Interest Rates (601)
- Equities (49)
- FX (45)
- Commodities (23)
- Credit (52)
- Property (18)
- Others (28)

Source: BIS Survey 2005
4.1 Current Practices

Breakdown by Scenario Types

Source: BIS Survey 2005
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4.2 Current Global Practices

Scenario By Regions

Source: BIS Survey 2005

Key Points of BIS Survey

• Senior management seems to be engaged – in 12 month period, 123 one-off scenarios were requested


• Sensitivity testing most common for interest rates and credit markets, less so for Equity and FX. Equity shocks are asymmetric towards crashes. FX shocks are in both directions.

• Market risk stress tests are most advanced. Need to develop robust stress test framework for credit risk

• Integration of market and credit risk remains an issue.
5. Regulatory expectations

- US banking supervisors have not mandated use of specific set of scenarios
- Stress tests should be both qualitative and quantitative in nature
- Incorporate both market risks and liquidity aspects of market disturbances
- Stress tests should be run on a periodic (at least monthly basis)
- Roles and responsibilities should be reflected in policies set by management and board of directors
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5.1 Regulatory expectations

- Stress scenarios should be well-documented and reviewed periodically by the senior management
- Comprehensive in coverage (globally across products)
- Material risks should be captured
- Customized for risk exposures being taken
- Fully Integrated into risk management
  - Provides actionable information to management
  - Are being used by management (to hedge/cut positions or keep under close watch)
6. Best practices

- Senior management actively involved in design and use of stress testing as an effective risk management tool
- Frequent running of stress test reports (daily/weekly)
- Periodic review of stress scenarios
- Risk tolerance based on stress scenarios and full revaluation used
- Customized scenarios pass “reality check” and are relevant to risk exposures and business strategy
- Reports tailored to the audience (desk/business/corporate level)
- Comprehensive integration of market and credit risks
7. Challenges ahead

“The frontier of challenges in the risk management process lies principally in the discipline of stress testing and scenario analysis to capture potential losses in adverse conditions in the “tail” of the distribution. This has been and will continue to be a principal focus of our supervisory efforts.”

- Timothy F. Geithner, President and CEO
  Federal Reserve Bank of New York
  GARP 2006 Convention in New York City.
7.1 Challenges ahead

- IT infrastructure may not be flexible for adding new scenarios or businesses.
- Fallout from future extreme stress events could be much worse than predicted by scenarios in use.
- Correlation assumption used for the aggregation of different asset classes (interest rates, equity, & credit) may not hold under actual stress event.
- Business-specific risks may not be fully captured within the stress test reports presented at the corporate level.
- Frequent review of scenarios may not be done to ensure that scenario are suitable in current economic environment.
7.2 Challenges ahead

• Unobservable risks (vol skew, default correlation) may not be fully captured

• The treatment of market liquidity in stress tests varies across firms (longer holding period vs. larger moves)

• Difficult to do stress tests on loan portfolios because of insufficient data and difficulty in marking the loan portfolio to the market

• Efforts to develop firm-wide stress tests for both accrual and trading books have been hindered by differences in accounting treatment and/or organizational structure

• Integration of risk management for different types of risks (market, credit and operational) remains an issue

• Stress testing practices continue to evolve…