

# Bank Asset/Liability Management



Prepared by Mary Brookhart

## Liquidity Risk Measurement Techniques and Stress Tests — Formulation of Liquidity Stress Test Scenarios

Having established an understanding of the liquidity risk measurement techniques and which potential analytical techniques to apply in the formulation of liquidity stress testing methodology (see the continuing series of articles, *BALM* March through May 2008), this penultimate article explores the formulation of liquidity stress scenarios. This article attempts to provide a practical approach to define and parameterize liquidity stress scenarios.

**Liquidity Stress Scenario Formulation.** Stress testing for liquidity risk enables risk managers and financial firms' management to determine the potential future net funding requirements under varying conditions. In the previous articles, it was made clear that stress testing facilitates the bridging between conventional risk measurement and effective, adequate, and robust measurement of liquidity. Stress testing is increasingly becoming a key risk management process that compliments sound management and contingency planning; it is also recommended and required by regulators. Stress testing makes provisions for varied but plausible situations through scenario analysis with the single goal of being prepared for potential liquidity problems. Most importantly, stress testing enables the making of appropriate liquidity management decisions to ensure the bank can withstand such events or scenarios without going bankrupt due to being illiquid. This dictates that an active management plan needs to be put in place and reviewed on an ongoing basis to ensure: the onset of potential problems is identified and the necessary actions are taken when specific signals of potential liquidity problems are triggered; the aversion

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of heightened liquidity strain on the bank; and, when a liquidity event does realize, the successful prevention of insolvency.

**Information from Stress Testing.** The formulation of liquidity stress testing needs to provide the information needed to ensure effective ex ante and ex post management decisions in respect of plausible liquidity stress scenarios. Leonard Matz (2005) explains that the stress scenarios need to provide information on the following:

- What can go wrong, how, and how bad can it go wrong.
- What the bank can do in advance to minimize the potential damage that may result from the worst case scenario.
- The opportunities for rapid and effective response need to be identified. This can enable the management to make a smooth transition from benign conditions to stress conditions.
- The suitability and adequacy of resources that are available to the bank to last during a stress event until such time-planned remedial actions are implemented.

**Liquidity Stress Tests Formulation Guidelines.** Is scenario selection and formulation critical to the stress testing of funding liquidity? Liquidity risk is very scenario-specific. The tactics that may be deployed in one liquidity scenario may not be suitable in another. The combinations of risk factors and ranges of potential liquidity scenarios are far more varied than for other financial risk. The impact of embedded customer options through deposit withdrawals or loan settlements and prepayments, the rollover and replacement of maturing deposits, the increasing of borrowings, extending liability maturities, selling of marketable assets at reasonable market prices, and the supply and demand for funds will vastly vary under different conditions.

Risk associated with the loan portfolio represents the greatest threat to the viability for banks. In general, it was felt by the Committee on the Global Financial System (CGFS, 2005:12) that the developments in liquidity stress testing area lagged those performed in the market risk area. The loan portfolio stress tests performed by banks focus mainly on credit variables, such as probability of default, recovery rates, collateral values, rating migration probabilities, and internal ratings assigned to borrowers.

Risk managers are striving for a more integrated risk management framework.

The interaction of various risks and their impact on liquidity risk necessitates that liquidity stress testing is done from an enterprise risk perspective taking cognizance of various risk impacts (Institute of International Finance (IIF), 2007:22). For example, an increase in credit losses will impact the ability to raise new funds at a reasonable price but also the funds not received from the repayment of the loans are funds lost. The inability to maintain profitability due to adverse interest rate movements may culminate in credit losses and the decline in market value of liquid assets. Finally, reputation damage due to questionable management effectiveness will ultimately impact funding liquidity, and so forth.

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However, according to the CGFS (2005:13), the segregation of risk management functions proves to be problematic for some institutions. The stress testing of trading portfolios, loan books, funding liquidity, and operational risk is often undertaken in different areas, making internal consistency across integrated scenarios difficult. Differences in accounting principles (i.e., accrual basis versus mark-to-market, the lack of trading markets for certain products, and differences in organizational structures and technology platforms) are all factors hindering the integration of stress testing, especially that of credit risk.

The following general considerations are provided by Matz (2005) for what must be made in the formulating of liquidity stress test scenarios:

- Scenario simulations must provide for the interactions between credit risk, interest rate risk, market risk, and liquidity risk.
- The stress scenario must recognize that liquidity problems do not arise in a vacuum.
- The lack of sufficient liquidity does not trigger a liquidity crisis.

- The stress scenario must be relevant to the bank, its business activities, balance sheet, and its business environments and clients.
- The scenario must be relevant to the economic environment.
- Stress scenarios must be severe enough to reveal *tail* exposure (i.e., improbable risk) but still be plausible. The probability of the scenario is of lesser importance although the plausibility is of utmost importance. History has proven that worst case estimates are invariably better anticipations than the actual stress events.
- The stress scenario must be detailed enough to highlight the vulnerabilities of the bank. The IIF (2007:22) also advocates that the identified vulnerabilities and the tolerance to any unmitigated funding liquidity risk be described in their policies and strategies. Limits and targets or triggers should be implemented to ensure that the bank operates within these specified tolerances.

In the formulation of liquidity stress scenarios, Matz (2005) provides the following recommendations:

- Use at least three different scenarios:
  - Normal business conditions inclusive of seasonal fluctuations
  - Bank specific funding crises
  - Systemic liquidity crises
- Define three characteristics for each scenario:
  - Scenario type: define the scenario based on location (i.e., local, national or international); is the stress systemic or bank-specific?
  - Stress duration: short or long
  - Stress severity: mild or severe stress

The following steps are applied in order to progress from the quantification of funding liquidity risk and attempting to close any net funding requirements by applying contingency liquidity. The approach is therefore designed to establish a process to determine funding liquidity risk for the specific scenario, that is, by quantifying the net funding requirement prior to taking any action to close the funding gap, and then attempting to close the funding gap by means of applying scenario specific assumptions about sourcing new funds and applying standby liquidity in terms of assets' liquidation.

- *Step 1.* The starting point for all scenarios is to project future cash outflows on all product classes based on the following assumptions underpinning the scenario:
  - All assets are rolled over and need to be funded
  - All liabilities roll off at maturity (renewal ratio = 0%)

The author's opinion is that it should be prudent to deploy in the cash flow forecast potential asset growth indicative of potential new business and NMD analysis or assumptions on deposit accounts that should be reflective of the scenario impact on such loans and deposits. The BCBS (2000:9) concurs that scenario cash flow analysis should include assumptions about future growth in assets and liabilities. Cash inflow forecasts require intellectual honesty and should not be biased towards meeting anticipated funding needs. Care should be taken not to mask risk by covering certain cash outflows with speculative cash inflows. Ignoring potential inflows will inevitably leave an incomplete cash flow projection and result in an unrealistically high forecasted liquidity need.

- *Step 2.* Determine the rollover vector per product class for liabilities representative of the stress scenario.
- *Step 3.* Assess the liquidity gap or net funding requirement after the partially renewal of liabilities as per Step 2.
- *Step 4.* Asset liquidation and counterbalancing of the net funding requirement for the scenario.
  - Liquidate unencumbered assets and securities. Highest asset quality determines the speed of liquidation and cognizance must be kept of discounts and haircuts applied to market prices and the duration of the stress scenario. It would be unwise to liquidate low-quality assets with negligible market liquidity that will take longer to sell in the market than high credit quality assets if the scenario entails a run on the bank that may last only several days at most.
  - The exploration of additional funding sources and capacity to increase existing funding must be determined under the scenario.
  - Prioritize actions of liquidation and capacity to raise additional liquidity based on market impact and associated costs. Reputation risk is of the es-

sence and cognizance must be kept, needless to say, dependent on the scenario definition, that the bank must be perceived by the market as being liquid and able to meet funding requirements.

- *Step 5.* Review stress testing results to determine time-frame of effective standby liquidity, days of sufficient cash flows and resultant liquidity coverage.

The CGFS (2005:7) reported that practitioners elect a trade-off between realism and comprehensibility. It was found that the more fully articulated the scenario is, the more complicated and less comprehensible the contents may become. The formulation of a hypothetical scenario may be judgmental in nature, which complicates the formulation and definition of risk factors and results. However, hybrid and historical scenarios need to caution against attempts to include all risk factors and their historic manifestation and influence on liquidity given the potential inadequate proxy they may provide to results when applied to current and future period scenario analysis.

The impact of an historic scenario (i.e., Black Monday when the Dow Jones dropped 23 percent) entails the assessment of what the bank's position would be if it happens again; it may mask the fact that the severe market event manifestation may be vastly different today. Therefore, the behavior of risk factors that created the event may act completely differently. It is, therefore, important to assess scenarios based on historical events but updated for current conditions. Matz (2005) argues that it is commonly applied in historic scenario stress testing to assume that the future stress events will be the same type of problems experienced by the bank or other banks as in the past, but the next crises is almost always different.

**Stress Scenarios.** Guidance on current industry practices on stress scenarios, especially in the banking, securities, and insurance sectors, can be found in the surveys and assessments conducted by the CGFS (2005:8) and The Joint Forum of the BCBS (2006a:8). The formulation of a liquidity stress scenario entails a reflection on how the bank's liquidity position may be impacted by adverse internal and external events. The source of the liquidity risk has to be assessed before any quantification attempts could be endeavored for the simple reason that certain events will have little or no impact on one bank but may result in dire consequences to another. Sources of

liquidity strain arise from the financial firm's business decisions to provide market liquidity, reputation damage to the firm, exposure of the firm to specific products and activities, and potential macro-economic changes. The BCBS (2006a:6) categorizes the following three sources of liquidity strain:

#### 1. Event-driven sources.

- Ratings downgrades on the firm or any negative news leading to a loss of market confidence are cited as the most significant firm-specific source of liquidity risk. Trading operations may be impacted through their ability to refinance current unsecured debt obligations that are the primary funding source for activities that cannot be self-financed. The downgrade of a banking firm may impact market access to unsecured borrowing (e.g., commercial paper from institutional investors, the reduction or cancellation of credit lines, and the reduction of deposits). Downgrades or material, negative, firm-specific news or rumors can also increase liquidity demands through margin calls, requirements to hold additional collateral, the need to provide credit enhancements or backup lines for securitizations, and the need to fund assets no longer capable of being sold or transferred via securitization.
- Funding liquidity risk also arises from systemic events, such as Long-Term Capital Management near-collapse following the 1998 Russian bond default. Historic systemic events may pose difficulties in formulating stress scenarios given that assumptions are required on the sources of systemic risk, the speed and timing of the event, its impact on the firm, and the behavior of counterparties. This information is not easily derived from historical data.

#### 2. Transaction- and product-driven sources.

- Transaction- and product-driven sources of liquidity strain are driven primarily from derivatives, off-balance sheet instruments (i.e., conduits and off-balance sheet insurance contracts with embedded options). Specifically at financial institutions, off-balance sheet products that may increase liquidity demand, especially during times of stress, include committed lending facilities to customers, committed back-up lines to special purpose vehicles or special purpose entities especially in securitization

transactions, and committed back-stop facilities to commercial paper conduits.

- The most significant transaction-driven liquidity strain experienced at banks and security firms originates from OTC derivative transactions and stock-borrowing transactions. Typically, sharp and unexpected market movements or events could cause additional collateral demand. Market events that may result in collateral demand are typically unexpected bankruptcy, market and counterparty defaults, or a ratings downgrade.
- Banks and security firms may experience liquidity pressures due to collateral calls on exchanges in connection with foreign exchange and securities transactions. According to the BCBS (2006a:7), firms reported that liquidity risk experienced due to these sources has been increasing over recent years. Higher trading volumes, information-efficient markets and ratings-linked behavior of market participants increasingly contribute to heightened funding liquidity pressure for firms.

### 3. Market trends.

Banking firms specifically report potential increased liquidity risk due to the movement to more volatile funding sources. Typical market trends identified include a move to increase wholesale funding, brokered certificates of deposit, internet banking, depositors' ability to switch funds among accounts electronically; all of which have contributed to more complex liquidity risk management (BCBS, 2006a:8).

According to the BCBS (2006a:9), liquidity stress testing scenarios at firms include both firm-specific and market-related scenarios. The banking sector predominantly focuses on stress scenarios segregated between firm-specific and market events. Only one-third of banks conduct stress tests incorporating a bank-specific event within broader unsettled market conditions.

The characteristics of the assumptions applied in the reported liquidity stress scenarios will be discussed in the continuation of this article in the July issue of *BALM*. Bank-specific stress test scenarios and market-related stress testing scenarios will also be addressed.

— Johnny Janse van Rensburg  
Nedbank

## Interfacing ALM with Strategic Planning

What bearing does strategic planning have on the asset/liability management process? How do these two important functional areas complement one another?

The strategic planning and ALM processes tend to receive a great deal of consideration due to: (1) regulatory mandates; (2) interest rate volatility; (3) enhanced local competition; and (4) declining profitability. As a result, many institutions are beginning to take a closer look at their planning and asset/liability management functions. Often, these two activities are not as well coordinated as they could be.

This article will highlight some suggestions for strengthening the interface between the strategic planning process and the asset/liability management function.

**Strategic Planning and ALM Differences.** Strategic planning typically adopts a long-term outlook, is largely qualitative in nature, and generally defines an organization's major direction, mission, character, line of business, and competitive positioning.

The asset/liability process, on the other hand, is often oriented toward the short term. The ALCO, which oversees this function, analyzes the balance sheet structure to ensure that the future development of the institution will allow the necessary flexibility to achieve overall financial goals.

**Symptoms of Poor Interface.** Several potential conflicts frequently limit the effectiveness of strategic planning and asset/liability management coordination efforts. Strategic objectives may not be achieved if the A/L position is based on an unacceptable level of interest rate risk. Quantitative planning analyses may also be based on inaccurate assumptions concerning the future cost of funds if the current and prospective asset/liability position is not thoroughly examined. These limitations often lead to erroneous decisions concerning the probability of attaining strategic profitability goals.

Conversely, the asset/liability objectives may not be consistent with the long-range strategic plan. A/L analyses may be based on unrealistic growth assumptions if the strategic planning process is ignored.

**Achieving the Proper Interface.** A number of strategies can be used to address these problems and strengthen the coordination of the two processes.

- *Assessing current A/L management practices.* An assessment of current operations, including success factors and operating constraints, should be one of the first steps in the strategic planning process. Examination of past, present, and future ALM positions is an important part of this assessment. And, of course, profitability, interest rate risk, liquidity, and capitalization are all key issues affecting A/L management that require close management scrutiny.
- *Identifying the appropriate cost of funds for strategic analyses.* Analysis of the relative profitability of various products and services is an important part of the strategic planning process. Reasonable estimates should be made of interest and fee incomes as well as non-interest expenses and charge-offs associated with various strategic alternatives.

The cost of funds is an important determinant of the profitability of any specific financial product or service. The implied interest rate risk associated with several alternatives with various costs of funds can best be determined by examining the asset/liability management position. In this regard, use of an average cost of funds can be misleading. These mean costs bear no relationship to matched costs of funds for various assets, since it is impossible to determine the profitability that should or can be derived separately from credit risk and interest rate risk.

In the strategic planning process, it is important to know which alternatives are the most and least profitable. The cost of funds selected for analysis of a particular scenario will have a major effect on estimated profits and, ultimately, on the strategic direction of the institution selected by management.

- *Evaluation of strategic plan and A/L management objectives.* The review of the strategic plan in light of ALM policies will allow management to focus on possible conflicts between the two plans. The ALCO may have sufficient flexibility to modify its strategy so that both sets of objectives can be met. This level of review may also show that either the strategic plan or A/L objectives must be changed.
- *Documenting objectives.* The documentation of objectives assures that they are properly communicated to and understood by various members of the incumbent team. This written communication will: (1) facilitate the examination of strategic ALM objectives, and (2) assist in determining if they are in agreement with

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*Several potential conflicts frequently limit the effectiveness of strategic planning and asset/liability management coordination efforts.*

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each other. The existence of written objectives will also facilitate the development of implementation plans to meet key strategic goals.

**Human Resources Coordination.** In order to properly and concurrently execute the strategic planning and ALM functions, there must be coordination of the human resources involved in each process. This can be accomplished effectively by requiring the membership of the organization's senior officers to serve on both the strategic planning and A/L management committees.

**Frequent Plan Review.** Periodic management reviews should be scheduled to assess the coordination and implementation of the strategic and ALM plans. The flexibility to modify these plans in response to any rapid changes in economic, financial, and competitive factors must be maintained.

Successful coordination of the strategic planning and asset/liability management process can be accomplished through implementation of the steps outlined in this article. Financial institutions that coordinate both efforts will find themselves better positioned to deal with the economic, regulatory, and competitive challenges that the industry faces today.

— Peter Mihaltian  
Southeast Consulting, Inc.

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## A Refresher on Duration and Convexity

The concepts of duration and convexity can be intimidating. The formulas to calculate them are not trivial. However, these concepts can be understood without using advanced mathematics. In this article, these concepts will be described in qualitative terms.

**A Duration and Convexity Analogy.** The concepts of duration and convexity can be related to driving a car.

We can predict how far a car will travel if we know its starting speed and acceleration. Similarly, we can predict price movements if we know a bond's modified duration and convexity. Thus, acceleration is to velocity what convexity is to modified duration. In both cases, we use a second order effect to improve an estimate provided by a first order effect.

**Duration.** Duration has two definitions:

- *Macaulay duration.* This is the weighted average term to maturity of an instrument's cash flows with the weights determined by the present value of each cash flow. This definition of duration views it as a longevity measure. However, this definition is useful only for simple option-free instruments. For example, how does negative duration translate into a weighted average time to maturity?
- *Modified duration.* This is the percentage change in price or value of an instrument due to a 100 basis point instantaneous parallel yield curve shift. This definition of duration views it as a value sensitivity measure. It is more universally applicable than the Macaulay definition. Duration provides a way of comparing apples with oranges. Duration also is used as a tool for managing interest rate risk. It facilitates the comparison of value sensitivity between two securities that could differ by coupon level, coupon payment frequency, maturity, and yield level.

Frequently, there is a discrepancy between the actual percentage change in price and the estimated change in price indicated by modified duration. Thus, duration can either overestimate or underestimate the actual price change. This difference occurs because duration is a local measure that is valid only for small instantaneous yield curve shifts. As interest rate changes get larger, this difference can get bigger.

**Positive Duration.** When interest rates rise (fall), the value of a positive duration instrument falls (rises). This behavior is typical of option-free bonds, mortgage loans, and mortgage-backed securities.

**Negative Duration.** When interest rates rise (fall), the value of a negative duration instrument rises (falls). This behavior is typical of mortgage servicing. When interest rates rise, prepayments slow down, mortgage loan maturity extends, and servicing cash flow increases.

**Convexity.** Convexity is a mathematical property of bonds and options; it is inherently neither good nor bad. Convexity describes the degree of curvature in the price-yield profile of a fixed-income security. The more convex the bond, the more the actual value change will diverge from the linear projection of change implied by modified duration. Thus, convexity is approximately equal to the correction required to the linear price-yield profile assumed by modified duration. Higher-order terms are necessary to fully capture the unexplained portion of the price-yield tradeoff. In practice, however, these terms are typically ignored.

Convexity also indicates how quickly a portfolio can become duration mismatched. It quantifies how the frequency of rebalancing may change as interest rates move. Convexity can be either positive or negative. If an investor purchases U.S. Treasury bonds, the position has positive duration and positive convexity. Prices rise more for a given yield decline than they fall for a similar yield increase. The position generates maximum returns when yields are volatile. In a highly volatile market, enhanced yield performance dominates the lower initial yield. The investment is attractive if the investor did not overpay for positive convexity.

If an investor holds mortgage loans or securities, the position has positive duration and negative convexity. Price declines more for a given yield increase than it rises for a similar yield decrease. The position generates maximum returns when yields remain relatively stable. In this case, the higher initial yield dominates the lesser price performance. The attractiveness of an investment depends on how much an investor paid for positive convexity or how much the investor was paid to incur negative convexity. The amount of yield volatility will determine the value of convexity, that is, higher volatility makes convexity worth more.

Thus, by investing in positions with negative convexity, an institution is effectively making a short volatility bet: that actual market volatility will be less than that implied in the incremental yield spread (compared with a bond without negative convexity) that the investor received for incurring negative convexity. If the investor guesses correctly, the reward will be excess spread in a stable market environment. If the investor bets wrong, the outcome will be too little incremental spread received in a volatile market.

**Positive Convexity.** Assume that two bonds have the same par value and price. As market yields fall, one bond appreciates in price faster than implied by its modified

duration (i.e., price acceleration). Conversely, as market yields increase, this bond's price decline is less than implied by its modified duration (i.e., price deceleration). This bond has positive convexity; a non-callable U.S. Treasury bond is an example.

Thus, when market yields decrease, duration lengthens and profits accelerate. When market yields increase, duration shortens and losses decelerate. Hence, the price increase associated with a given decline in interest rates exceeds the price decline for the same-sized interest rate increase.

**Negative Convexity.** Mortgage loans and mortgage investments have negative convexity due to the prepayment option granted to the borrower. For example, when interest rates fall, a borrower generally prepays if current market interest rates are sufficiently below the contract rate on the mortgage. This shortens the average life or effective duration of the mortgage.

The term *effective duration* is used instead of *modified duration* because the presence of prepayments changes the level of cash flow. Modified duration assumes constant cash flow. The instrument experiences a price compression or price increase deceleration. Its price increase is less than that implied by the instrument's modified duration. When market rates fall, a bank reluctantly loses high-yielding mortgage securities because of prepayments, just as reinvestment rates fall.

As market yields rise, effective duration lengthens and price declines accelerate compared with what is implied by the instrument's modified duration. The price increase associated with a given decline in interest rates is smaller than the price decrease for the same size interest rate increase.

Conversely, when interest rates increase, prepayments generally slow, thus extending average life and effective duration. In this case, however, a bank would prefer a shorter average life to replace low-yielding assets with higher-yielding assets in a rising-rate environment.

If the current level of market yields is significantly above the coupon on the bond under review, the bond's price behavior resembles that of a non-callable bond (i.e., positive convexity). Thus, a given security can have negative convexity in a low interest rate environment and positive convexity in a high interest rate environment.

The effective duration of a mortgage security will range between the duration of an equivalent non-callable bond and the duration of the call date. The former (latter) occurs when market yields are significantly above (below) the outstanding mortgage's coupon.

Mortgage servicing has negative convexity because, as interest rates rise (fall), duration becomes less (more) negative. As interest rates rise, the benefit of slower prepayments is offset by higher discount rates, which is a drag on market. Thus, mortgage-servicing value increases at a rapidly decreasing rate when interest rates rise. Conversely, as interest rates fall, prepayments accelerate and dominate the benefit of lower discount rates, which causes value declines to speed up. Thus, mortgage-servicing value declines at a rapidly increasing rate when interest rates fall.

**Summary.** Duration and convexity can be explained in terms of the magnitude, direction, and rate of change of value to interest rate movements. It is more appropriate to use duration as a proxy for value sensitivity than as an estimate of weighted average time to maturity.

— Steven J. Leric

#### Correction:

The article entitled "Path Dependent Decision Making: A Simulated Game Plan for Optimal Performance" by Michael Drews should have stated that Real Options Analysis (ROA) [not Return on Assets] is an analytic technique that values investments requiring future contingent decisions at various points in time based on prior possible outcomes up to the time of the decision.

## **Bank Asset Liability Management**

### **Editor**

Peter A. Mihaltian, President  
Southeast Consulting, Inc.  
212 S. Tryon Street, Suite 1680  
PO Box 470886  
Charlotte, NC 28247-0886  
(704) 338-9160  
E-mail: [SECI@aol.com](mailto:SECI@aol.com)  
Web site: [www.southeastconsulting.com](http://www.southeastconsulting.com)

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