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Prepared by Mary Brookhart

Effectively Testing for Basis Risk and Yield Curve Shape Risk in Interest Rate Risk Analyses

New regulatory guidance sends a clear message that traditional interest rate risk (IRR) analyses need to be expanded to incorporate testing for basis risk and yield curve shape risk. The issue is a real one, as changes in driver rate relationships are key influences determining the IRR position of most institutions. Proven solutions for the new mandate exist that can be readily incorporated into existing asset/liability management committee (ALCO) processes.

The new guidance (*Advisory on Interest Rate Risk Management* (2010-1A), January 6, 2010) directs that earnings at risk (NII IRR) testing be expanded to examine potential exposures associated with different driver rates (interest rates, new auto rate, FRM acceptance rate, etc.) moving at different speeds (basis risk) and steeper or flatter yield curves (yield curve shape risk). These types of tests are conducted in selected advanced ALCO earnings at risk assessment programs. But such testing is not the norm, so for most institutions current IRR analysis activities need to be expanded to comply with the new guidance.

Institutions new to testing basis risk and yield curve shape risk can benefit from the experience of current advanced programs. These show that three elements are needed for a successful basis risk and yield curve risk analysis solution. These are (a) ALM model setup and fine tuning, (b) defining the appropriate rate tests, and (c) effective communication of the now multi-dimensional view of the institution's NII IRR position.

ALM model setup is usually straightforward. Basis risk and yield curve shape risk test scenarios are defined for intake into the model in the same way current forecast type data is. That is, the new test scenarios load into the model as would any other type of time-dependent rate scenario. Check with your model supplier's support function on how to do this if you are not currently importing forecasts for IRR testing or budgeting applications.

It may be necessary to adjust the model's beta coefficients (which link driver rate changes with new volume pricing) if the current application is set up to mute repricing relative to driver rate changes. The most important case is for core deposits, where betas are often used to reduce repricing relative to rate shocks. The easiest fix is to tie core deposit rate paid changes to a short term rate (e.g. the 3 month Treasury bill) and leave the current betas in place. If core deposit repricing is tied to longer term driver rates, then current betas will need to be modified or eliminated to reflect the fact that longer term rates are moving at only a percentage of the 100bp driver rate change.

Selecting the right basis risk and yield curve shape risk scenarios is a more challenging task. The ideal test regime is one that a) comprehensively projects future rate paths over time incorporating quantified basis risk and yield curve shape risk relationships, b) provides a stable test environment through time, and c) has an identifiable and defensible audit trail. Consider the potential set of testing solutions in Exhibit 1.

The limited capabilities of standard rate shock and rate ramp earnings at risk tests are clear. These tests examine repricing mismatch and option related IRR sources but ignore basis risk and yield curve shape risk. The motivation for the new guidance is very clear in the shortcomings illustrated for standard rate shocks and rate ramps.

Forecasts based on econometric assessments of future economic and monetary conditions have traditionally been the next step up in IRR testing. They incorporate basis risk testing and a degree of yield curve shape risk assessment. But experience shows

Exhibit 1. Earnings at Risk Test Comparison Matrix

Interest Rate Test	Rate Changes Take Place over Time	Driver Rates Move at Own Speeds	Specific Yield Curve Scenarios	Stability of Tests Period to Period	Clear and Defensible Audit Trails
Standard Rate Shocks	No	No	No	Yes	n/a
Standard Rate Ramps	Yes	No	No	Yes	n/a
Econometric Forecasts	Yes	Yes	No[a]	Not Always	Proprietary Models
Judgmental Ramps and Forecasts	Depends on Specifications				Qualitative
Statistical Based Risk Ramps	Yes	Yes	No[b]	Yes	Yes
Statistical Based Yield Curve Shape Ramps	Yes	Yes	Yes	Yes	Yes

Notes: a. Most forecasts define a change in yield curve shape over time due to the fact that short term rates move at faster speeds than long term rates. This is not a formal yield scenario, however.

b. Basis risk ramps define a change in yield curve shape over time because short term rates move at faster speeds than long term rates. This is again not a formal yield scenario, however.

that they can vary sharply from period to period, as forecast parameters shift and differing vendor adjustments are made (e.g. based on Fed watching). This unfortunately often leads to ALCO or board members arguing as to whether the forecast change is warranted, rather than concentrating on NII IRR. The lack of consistent forecast evolution also negates trend analysis and weakens ongoing exposure comparisons to IRR limits.

Judgmental ramps and forecasts are sometimes encountered. These are defined and controlled over time by their creators. Such rate tests are often innovative and uniquely focused on institution specific exposures. But they are rarely qualitatively constructed and as such do not correctly incorporate all of the lags and interdependencies found in driver rate interrelationships. Judgmental interest rate tests are further handicapped by weak audit trails and may suffer from inconsistency from period to period unless well designed.

The various limitations of the above mentioned interest rate tests lead to statistical-based basis risk and curve risk tests as arguably the best solution for assessing basis risk and yields curve shape risk in NII IRR analyses. These tests have a series of advantages.

They are based on advanced statistical analyses of long-term driver rate relationships as evidenced in, for example, the last 25 years of financial market experience. This firmly anchors the projections in empirically observable data and creates a clear audit trail.

The statistical analyses create a system of rate equations that links changes in a specified short term rate (e.g. the 3 month Treasury rate) to changes in every other driver rate defined. Basis risk ramps are created by incrementing the 3 month Treasury rate by a specified change over a specified time period (e.g. +200bp over 12 months). Projections for all other driver rates follow along at their historically correct speeds. Yield curve shape risk tests are created in a similar fashion. Here, however, a long term rate is changed by a small amount and a short term rate by a multiple of that (e.g. +10bp for the 10 year Treasury rate and +100bp for the 3 month Treasury rate). All other driver rates evolve over a specified time horizon in response to those changes.

Because the projections are equation based, any set of rising and declining basis risk tests or steepening and flattening yield curves can be defined and updated every month. The inherent stability of the underlying equations, and monthly updates, ensure that the rate tests evolve over time with changes in the interest rate environment rather than jumping from one period to the next. Further, all statistical-based rate tests have clear and unambiguous audit trails to historic data via the estimation process and equation system.

An example of a statistical based basis risk test is

presented in Exhibit 2. In this test, the 3 month Treasury rate is linearly advanced by a total of +200bp over a 12 month period and then held constant thereafter. In the upper display the lesser changes in longer term interest rates compared to short term interest rates is apparent. In the lower display other driver rate relationships are illustrated. The comparatively slow changes in such key banking sector driver rates as MORT30 (the 30 year FRM acceptance rate) and the new auto rate are evident. The varying rate changes over time are the source of basis risk.

Yield Curve Shape Outcomes. Exhibit 3 depicts resulting yield curve shape outcomes at the conclusion of their 12 month statistical-based forecast evolution. The curves are defined for iterations of a 100bp change in the 3 month Treasury rate and a 10bp change in the 10 year Treasury rate. The upper display clearly shows the different yield curve shapes examined by IRR analyses using the test scenarios. The lower display shows the marked differences in the variability of short versus longer-term driver rates in yield curve shape testing. The varying rate changes seen in the alternate curves and associated driver rates are the source of yield curve shape risk.

Exhibit 2. Example Basis Risk Test: +200 bp Ramp

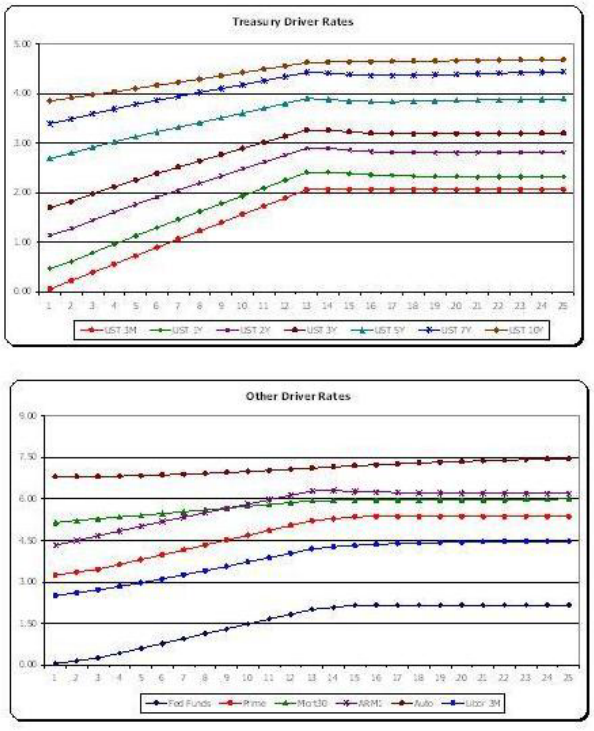
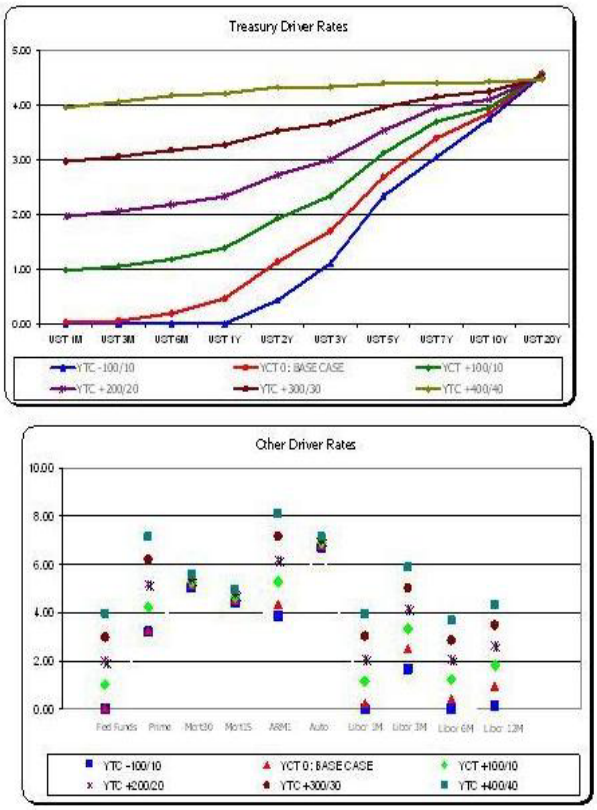


Exhibit 3. Example: Steepening & Flattening Yield Curve Shape Risk Tests



A Multi-Dimensional View of Interest Rate Risk. Multiple tests dealing with basis risk and yield curve risk create a communication issue because the volume of rate tests and scenario results is daunting, and audiences are easily subject to information overload. How can we effectively present a multi-dimensional view of IRR to all relevant audiences? As with any data presentation, there is no one answer; material provided must be tailored to the audience. Best practice for high level oversight users of the rate test information, e.g., senior management, board members, and regulators, is to present results in a simple graphic display, with additional detail kept to a minimum. For ALCO type audiences, the outputs for each rate test and scenario should be presented, preferably in table format (associated graphics are optional). Model quality assurance and model validation require category level detail for each rate test by scenario, in whatever is considered the most convenient format.

Case Studies. How does it all work in practice, however? The best way to examine basis risk and yield curve shape risk testing and see alternate communication solutions is to examine IRR analyses

Exhibit 4. NII IRR Profiles: Alternate NII IRR Rate Tests

Standard Rate Shocks	-100	-50	Base Case	+50	+100
Net Interest Income	11,081,635	11,192,147	11,229,824	11,215,526	11,191,122
Percent Change	-1.32%	-0.34%		-0.13%	-0.34%
Standard Rate Ramps	**-200**	**-100**	**Base Case**	**+100**	**+200**
Net Interest Income	11,347,585	11,303,903	11,229,824	11,171,241	11,074,440
Percent Change	1.05%	0.66%		-0.52%	-1.38%
Statistical Basis Risk Ramps	**-200**	**-100**	**Base Case**	**+100**	**+200**
Net Interest Income	11,278,607	11,270,018	11,229,824	11,022,584	10,759,153
Percent Change	0.43%	0.36%		-1.85%	-4.19%
Statistical Yield Curve Shape Ramps	**-200/-20**	**-100/-10**	**Base Case**	**+100/+10**	**+200/+20**
Net Interest Income	11,209,996	11,234,067	11,229,824	11,069,338	10,823,311
Percent Change	-0.18%	0.04%		-1.43%	-3.62%

outcomes in a case study. This will also address the question of whether basis risk and yield curve shape risk are factors that need to be considered. Do such tests really illustrate new dimensions of IRR? Is the current regulatory concern truly warranted?

The case study institution holds 31% of its assets in longer term fixed rate assets and callable investments. However, almost 40% of assets are short term repricable commercial loans. Remaining assets are represented by small investment and consumer lending portfolios. Funding is approximately 65% shorter term CDs, quick to reprice premium rate MMDAs, and short term wholesale funds. The remaining 35% of funding is made up of traditional core deposits (low rate paid and long term) and longer term CDs and wholesale funds.

Standard rate shock and rate ramp scenarios were produced using internal ALM model functionality. Statistical based basis risk and yield curve shape risk scenarios were loaded from Excel files using the ALM model's rate forecast import capabilities. (Source for the statistical based basis risk and yield curve shape risk scenarios is the MPS *SmartRamps* service. *BALM* subscribers may obtain a complimentary copy of the latest *SmartRamps* rate test projections by requesting it via *info@mpsaz.com* or by contacting their MPS sales consultant.) The rate tests were run using identical static balance sheets, over a 12 month forecast horizon.

Exhibit 4 presents NII IRR data for the four different types of rate tests at an ALCO level of presentation detail. As a general statement, the case study institution has an indirect NII IRR profile - it is always exposed to rising interest rates and (mostly) vice versa. The results are surprising, though, in that indicated rising rate exposures to basis risk and yield curve shape risk are greater than the exposures estimated by traditional rate shocks, and the reduction in NII projected by the shock test in declining rate scenarios is not generally seen in the other rate tests. The differences in measured NII IRR are not trivial either, confirming the validity of emphasis in the new IRR guidance on potential basis risk and yield curve risk exposures.

Differences between Outcomes. Why are the rate shock NII IRR outcomes so different? Much is explained by the many driver rates embedded in the institution's balance sheet. When these are forecast to move at their own specific speeds, the shorter term (faster changing) driver rates that dominate the funding side exert more repricing weight. The rate shock (and rate ramp) scenarios miss this issue because all driver rates are moving by the same amount. A key second determinant of the rate shock outcomes is that, in these scenarios, driver rates change instantaneously by the full amount of the specified interest rate change. This causes the options in the balance sheet (here mortgage prepayments and investment calls) to be triggered faster and to a much larger degree than they are in the other scenarios. The effects are more pronounced in declining rate scenarios because option influences are magnified by the rate shocks to a greater degree in those scenarios.

The NII IRR profiles presented in Exhibit 4 show that statistical based basis risk and yield curve risk tests clearly provide important new earnings at risk information to senior managers, board members, and regulators. But how can we make that information obvious to these higher level oversight audiences?

Profiles Presentations. Traditional presentations of NII IRR profiles most often take the form of bar or line charts showing NII in Base Case and in each scenario. This is

adequate for a single rate test but the approach is cumbersome for multiple tests, where either multiple bars or lines must be used in a single chart or multiple separate charts defined.

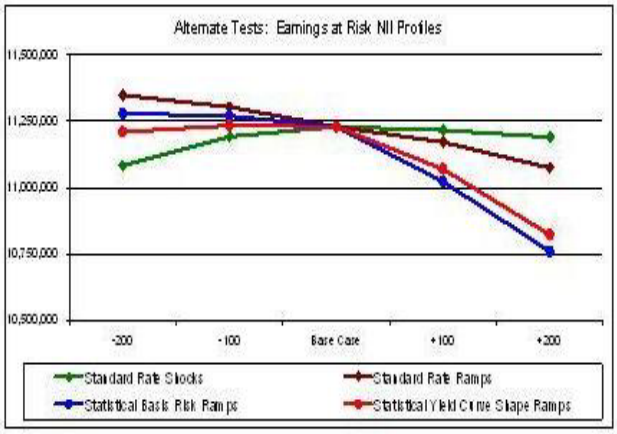
Line chart depictions of multiple rate test outcomes, such as that seen in the upper display in Exhibit 5, work best if a traditional graph approach is used. The institution's generally indirect NII IRR profile and the greater exposures to rising rates in the basis risk and yield curve risk scenarios are evident. But the presentation is a flat and somewhat unconvincing demonstration of the institution's NII IRR risk position across the multiple measures.

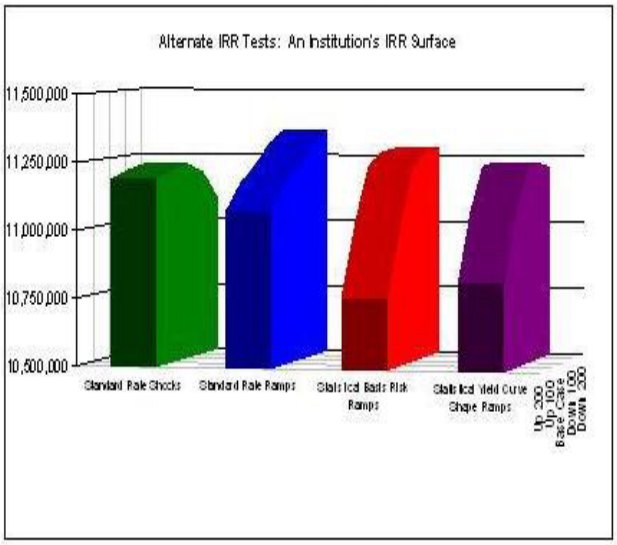
There is a better way to both conceptualize and show the NII RR analyzed in the case study. This is to refer to the set of rate test NII IRR profiles as the institution's *IRR surface* and illustrate this in a three dimensional graphical environment. This has several advantages. The IRR surface concept implies that NII IRR is a broadly defined concept, across multiple rate tests, rather than a single dimensional concept. **This is a key new perspective defined in the new IRR guidance**. The use of three dimensional graphics (see the lower display in Exhibit 3) provides a clear view of the shape of NII IRR in each rate test, i.e., its direction and magnitude. The greater NII IRR exposures to rising interest rate environments in the basis risk and yield curve risk tests is unmistakable in the three dimensional graphics, for example.

Conclusion. Expansion of earnings at risk testing as directed in the new IRR guidance is readily accomplished and provides important new insights into potential NII IRR exposures. Conceptualizing the multiple NII IRR rate test outcomes as defining your institution's IRR surface and presenting rate test outcomes in a three dimensional format can communicate the multi-faceted face of earnings at risk effectively. The new IRR guidance, while definitely requiring more effort, is not a threat to ALCO IRR analysis programs. It is rather an opportunity to demonstrate the added benefits available to your institution from a more thorough examination of NII IRR.

William McGuire
McGuire Performance Solutions, Inc.

Exhibit 5. Illustration: Traditional IRR Graphic & IRR Surface





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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
Web site: www.southeastconsulting.com

Publisher's Staff
Manuscript Editor
Diana Calmes

Editorial Inquiries
Peter A. Mihaltian

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