Large financial businesses borrow and lend money in various forms. These activities are carried out relatively independently of each other and can result in large interest and exchange-rate mismatches. The value of the portfolio may be susceptible to movements in these variables. Vinay Kolhatkar compares ways in which this risk is measured and outlines how a combinatorial approach can be made very effective.

Commercial banks take out a variety of contracts with customers, such as home loans and personal loans, with rates fixed for up to seven years. Rates for corporate term loans and leasing deals are sometimes fixed for longer than 10 years. On the liability side, with most deposit products the discretion to vary rates is firmly with the institution. However, non-fixed-rate deposits are sensitive to a general rise in the level of rates, particularly the much-publicised RBA cash rate.

Superannuation and life fund managers have a wide variety of ways of acquiring funds from retail and professional investors. Income annuity deals in Australia, for example, offer defined annuity streams after retirement or retrenchment up to 15 years or for life. And some have annuity streams that are linked to inflation. Funds are not necessarily (and sometimes cannot be) directly invested or synthesised into assets that try to approximate the sensitivity of the liability stream to variables such as interest rates, exchange rates or inflation.

The problem of surplus risk or mismatch risk becomes more complex when either asset payoffs or liability payoffs become uncertain. An example of the former is when financial companies acquire property collateral in the process of a loan going bad and both the timing and the cash inflow from the property is uncertain. For most pension fund managers, liability payoffs which depend on mortality rates, inflation (as measured by CPI) and retirement frequencies and choices can be highly uncertain.

Measuring the risk

Gaps and duration are quick measures of the nominal interest-rate risk mismatch. Once risks become more complex, due to inflation impacts and timing uncertainties caused by prepayment possibilities, simulating outcomes becomes the only tool that can capture the full essence of such risks. However, simulations are never fully objective and cannot easily crystallise risk into one index.

For direct and pure interest-rate risk, gaps can be used successfully. Unfortunately, much of the financial literature on this subject has treated gaps as an antiquated 1960s banker's tool that has been superseded by duration in sophistication. There is a common presumption that interest-rate repricing gaps are used as a primary risk-control measure and that the risk manager using gaps is usually trying to close them, one by one. The reality is that gap reports, properly used, can overcome the shortcomings of the first-generation duration approach by supplementing a primary duration approach as a secondary risk-control measure.

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It is well known that first-generation duration measures such as Macaulay's duration assume that the par yield curve will move in parallel. Thus, a duration match or a near-match can hide extensive mismatching in cash (repricing) flows. Non-parallel shifts in the yield curve can then wreak havoc with such a "matched" position, potentially resulting in considerable losses.

Higher-order duration measures can provide non-parallel matches but these matches are often based on historic or specific volatility relativities between the long and short ends. These may not hold in the future. Absolute risk control is provided only by exactly matching each cash (repricing) flow for cash (repricing) flow. This is where the gap report becomes useful.

Measuring the dollar-value impact of a basis point parallel change in the yield curve on both the assets and liabilities sides gives a net impact. By using the real zero-coupon yield curve, one is at least using a second-order duration measure. Systems have made it as easy to do this as to calculate a Macaulay duration. One can then limit the dollar-value sensitivity of the portfolio under a parallel shift assumption. Second, by dividing the range of the yield curve into extensive sections and by limiting the cash (repricing) flow mismatches in each section, one can limit the extent of non-parallel risk in the portfolio.

Note that the two limits (present value sensitivity and gap limits) are not interchangeable; the riskiest position allowed under one may easily break limits in the other. The riskiest position while meeting each time-band gap limit will certainly break the dollar sensitivity limit if the limits are properly configured. Using gaps in this way as a concurrent tool (with parallel duration measures), rather than using gaps to massage near-term accounting income, enhances risk control.

The trouble is that a whole range of contracts provided in the managed funds and insurance sector cannot be easily slotted into gaps or duration equivalents. Contracts that, for example, provide annuities until death, inflation-linked long-tail annuities, options to terminate early without compensation of full economic costs or contingent payouts cannot be easily modelled in a static scenario. Similarly, a range of financial products on the lending side, such as personal loans and motor leasing, have implied contracts in which either regulation or competitive pressures prevent the imposition of an economic penalty (mark-to-market costs) for early termination (embedded options).

Banks also source liabilities through floating-rate deposits in savings and transaction-based accounts. Because of competitive pressures, the pricing on these products bears only an approximate and indirect relationship with the market yield curve.

Modelling the sensitivity of the entire business portfolio is one way of estimating the aggregate effect. However, a proper asset liability simulation requires extensive data, at potentially high computer costs. Sometimes it is cost-effective to model only those parts that have indefinite cashflows and obtain a range of sensitivities for such option-embedded products; this can be crystallised to an index and then fed back into an index-related risk measure such as duration or a dollar-sensitivity report. The modelling also provides an indication of the true cost of such products including the cost of the embedded option. The business can then decide whether the product profit margin will recoup the true cost over time.

Another risk control method that is often used, by US regional banks as well by Australian banks, is the cumulative gap measure. The cumulative gap results from adding net repricing sensitivities from day one while moving along the yield curve. Limits on such forward cumulative gaps restrict the amount of the next period's accrual income at risk. This is a useful measure if it is used as a supplement in organisations that are particularly susceptible to their next publicly reported result. By itself, however, the cumulative gap is dangerously inadequate.

While one risk tool is insufficient to model entirely a diverse financial portfolio, a fairly comprehensive interest-rate risk control can be effected by using a combinatorial approach as follows:

1. Use historic patterns and micro, product-based simulation to generate time-band approximations for difficult, cashflow-uncertain products;
2. Having slotted all the relevant sensitivities into time bands, calculate dollar-value sensitivity of the portfolio as though no basis risk existed and with the assumption that the yield curve will move in parallel. One then limits the dollar-value sensitivity to a value that sits comfortably with the risk appetite of the institution;
3. Then additionally limit the absolute level of mismatches in each fine time-band so as to limit risks to non-parallel shifts in the yield curve;
4. Systems permitting, one can then use a macro simulation to look at the sensitivity of the portfolio in aggregate, particularly where there are large basis-risk effects in the portfolio and where one wants to see the effect of outliers on both economic value and on the flow of reported accounting income.

By unbundling the sources of risk and treating direct interest-rate risk in this manner, only the variables that need to be simulated are simulated. Otherwise there is a significant possibility that simultaneous simulation of several variables can overtake the user's capacity to discern individual effects. Moreover, mega-simulations cannot easily drive actionable decisions in decentralised organisations.

The risk-neutral benchmark
It seems unarguable that the wisest approach must be to be immunise the value of a business against uncontrollable exogenous variables such as interest rates, inflation and exchange rates. Outright positioning in these markets involves playing a zero sum game, one in which the business can win only at the expense of other players, typically wholesale and institutional. Not only do a great many organisations believe that their ability to predict the course of financial variables is better than the market average; some virtually depend on it. In the case of banks and funds or life offices which perform large market-making functions for financial derivatives or have extensive economic research and networking units, such a belief may be perfectly reasonable. Note that the belief assumes that they will beat the weighted average market forecast embedded in current risk-free contracts (eg, yield curves and forwards), not merely that interest rates will fall or a particular exchange rate will rise.

They can then choose to expose the economic value of the firm they man-
age to exogenous variables such as interest rates, inflation or exchange rates. However, such exposure must be controlled, deliberate and measured. Ideally, this exposure, along with the potential downside, must be reported to directors, auditors, regulators, trustees and analysts. Where public information is required for shareholders, policyholders or trustees, the report should at least take the form of an index summarising the level of risk taken and the potential variability in economic performance, reported performance and variability in the surplus account.

Organisations are also valued by external agents such as professional investors, analysts and regulators. At the moment these players do not have adequate information about the “ex ante” risk that is run within. Investors in particular could be assigning a perceived stability value to organisations like finance companies and banks that show stable reported income in the core business. An exercise that protects the true economic value as seen from the inside could expose the organisation to perceived margin instability. A simple hypothetical example illustrates this point:

Consider a portfolio of $A100 million. Assume that the portfolio reports an income performance on an accruals basis. Suppose the asset manager has bought four zero-coupon $A bonds of one, three, five and seven-year terms. Suppose further that the portfolio was constructed by issuing fixed-rate (defined benefit) liabilities of $A80 million ($20 each in one, three, five and seven years) and by residual contributions (equity) of $A20 million. A conventional interest repricing gap report would then look as shown in Figure 1.

Suppose that it is not certain that the portfolio will be liquidated exactly at the end of seven years but could be sold at any time, and that one of the tasks is to prevent the sale value from fluctuating too much. The manager has the following choices:

1. The margin on $80 million is locked in but $5 million in each of one, three and five years faces reinvestment risk. One could shift this investment to $15 million (5×3) of seven-year zeros. Reported accrual income would then be stabilised for seven years if maturing assets and liabilities are reinvested for the same duration (Figure 2).
2. The undefined benefit unitholder (the equity holder) in this case loses heavily on the sale value of the investment if interest rates rise. One way to immunise the sale (economic) value of the portfolio against rate changes is to extend the (Macaulay) duration of the liabilities (with pay fixed swaps, say) until 80 times the liability duration equals 100 times the asset duration. Say the manager has switched to a 20, 20, 20, 40 asset profile in order to meet criterion 1. For the purposes of argument, let’s say the manager can pay fixed zero seven years in a swap and receive daily floating, and executes such a swap for a notional $20 million.

After adjustment 2 (Figure 3) the economic value is fully insulated against rate changes but the accrual report shows considerable fluctuations from interest-rate changes (from the daily repricing floating leg of the swap).

Although simplistic, this example illustrates that where accrual reported income considerations are perceived to be driving external valuations, the asset-liability manager is in a bind. One either manages the risk to economic value down to zero or manages a perception (stability in reported margin income), but there is direct conflict between the two. Leveraged banking organisations are likely to run into this conflict in an asset-liability management exercise for balance-sheet interest-rate risk.

Many Australian banks do, in fact, define the asset-liability management task as one of stabilising net interest-income streams rather than a dual task of insulating product margins and economic value from movements in financial variables such as interest rates.

Similarly, fund managers often have, and are measured against, asset-only objectives such as maximising asset value, matching a market benchmark or attaining a certain peer rating.

The Federal Reserve Board in New York is considering a draft paper on assessment of balance-sheet interest-rate risk. The paper suggests, inter alia,
that one measure of an institution's level of interest-rate risk would be the change in economic value arising from a 100-basis-point shift expressed as a percentage of the total asset base.

The recently released Bank of International Settlements proposal will also tend to approximate the risks to true economic value. These measures, if implemented, could force Australian commercial banks to target multiple objectives for asset-liability management if they are not already doing so.

One way out of this dilemma is to insulate product margins and mark to market the effective positioning of equity funds invested in the business, and report the overall economic outcome along with the margin income on the insulated business. The economic outcome of rate fluctuations is then fully reported as it materialises, instead of lying dormant.

For managed portfolios which are defined benefit with liability certainty, duration mismatch is an excellent measure of the extent of immunisation. However, there is no clear way of defining an index of surplus risk if liability streams are highly uncertain. Once liabilities are uncertain, immunisation is so difficult that equities can readily replace bonds at a very small increment to overall surplus risk (Leibowitz et al). This is a welcome result from the viewpoint of the government or macro-economists and equity managers, as it has the potential of reducing total debt in the economy.

Inflation risks are more complex in that CPI increases can lead to a blowout in the liability cashflow. These increases are not necessarily well correlated with asset price inflation, which is a much stronger determinant of investment performance. Even index-linked bonds have not been found to be sources of low risk in the UK (Eichholtz et al).

**Aggregate assessment**

Aggregate assessment entails the transfer pricing of funds to users and suppliers within the business. The transfer price can be worked out on the basis of a "treasury-risk-free" match, leaving only operational and credit risks within the line unit. Adding adequate margins for credit, liquidity and operational risks to the risk-free benchmark gives a rational ("fair") price for the product. Competitive pressures do not allow a fair return to be earned on all product lines at all times but knowing the fair price serves as a basis for rational entry and exit decisions.

A second side benefit is that aggregate data collection and summarisation also provide senior management with a bird's-eye view of the business as a whole.

**Accounting developments**

Proposed accounting standards in Australia (ED 59) require that a "hedge", in order to have accounting treatment similar to the underlying transaction in aggregate exercises, has an equal or partial (but not greater) equal offsetting price effect. It is not clear how a banking organisation wishing to take deliberate positions in the aggregate, opposite to the one inherited, would effect them without losing the benefit of similar accounting treatment. Yet it can easily get similar accounting treatment if part of the identified and known exposure is left unhedged in order to run a deliberate "position".

Accounting standard AAS25 (March 1993), Financial reporting by superannuation plans, will require superannuation funds to crystallise surplus risk. Similarly, the proposed standard for employee entitlements, ED53 (August 1991), if adopted, would require employers to integrate surplus account volatility into their financial accounts.

These are excellent measures, and managers with a good handle on asset-liability mismatch management have less to fear.

**Conclusion**

Asset-liability mismatch risks inevitably arise in large and diverse financial businesses. It is difficult for analysts to assess performance adjusted correctly for risk, as reporting standards at this stage do not require organisations to detail their management philosophy nor the average "ex-ante" risk that is run. Significant approximation has to be accepted if a uniform measure is to be applied externally by regulators, analysts and accounting bodies as only combinatorial tools have some chance of effectively encompassing the full complexity in the balance sheet.

Moreover, risk neutrality cannot be defined without reference to an investment horizon and is subjective to the extent that claimholders do not have uniform investment horizons. Multiple constraints around divergent risk neutralities is a valid objective. This validity is not recognised in proposed accounting standards.

**REFERENCES**


