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RISKS AND REWARDS

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Conceptual Framework—Thoughts from W. Paul McCrossan

by W. Paul McCrossan

Editor's note: *This is an excerpt from a longer address to the International Accounting Standards Board on guiding principles. As the IASB and the European Commission work out application of a "fair value option" and continue to debate standards for portfolio hedging, these principles affect actuarial practice and risk management. ALM practitioners are familiar with the debate: how efficiently do insurance contract-holders and pension plan members exercise their options? Why are deposits automatically classed as liabilities? Which assumptions lead to useful information and sound management decisions, and why? Mr. McCrossan is a member of Eckler Partners, an affiliate of Milliman Global. The unabridged version of this paper will be posted to the Investment Section page of the SOA Web site.*

Introduction

At the November meeting of the IASB's SAC, I raised strong support for the concept of a priority project to accelerate the development of a new conceptual framework for the IASB with emphasis on the role of reliability, the definition of liability, the meaning of probable, the effects of contingencies (i.e. contingent probabilities), the unit of account and accounting for contractual rights and obligations. I argued:

- That the conceptual framework project should have priority;
- That the project should also consider whether the "efficient market" hypothesis should continue to be implicitly assumed in the conceptual framework or whether "behavioral economics" should be substituted;
- That the project to revisit the framework should also reexamine the role of probability in general (rather than as restricted by the term "probable" in the context of recognition);

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Chairperson's Corner

by Michael O'Connor

This chairperson's corner will address many of the upcoming challenges for the Investment Section, how it might affect you, and how we will call upon you to help. There are a number of changes going on at the SOA, many that I am sure you are aware of. Specifically, the roles for the SOA sections are broadening to include many of the roles and responsibilities that used to reside in the practice areas. While there are some activities and functions that are still being developed further, many of our roles are now very clear. The biggest changes are in the following areas:

- Thought leadership and strategy. The sections will be more involved in evaluating challenges and opportunities for the profession and the members of the section. The sections will be more closely involved with the Board of Governors to ensure the SOA strategic direction is in sync with these needs. I am happy to say that Mary Hardy is our section's partner on the board.

- Advocacy. We will seek out new opportunities to be an advocate for the actuarial profession, and we are currently evaluating different opportunities to do this.

- Research. The Investment Section will be responsible for many of the finance research activities of the SOA. We will work with the Risk Management and Financial Reporting sections to coordinate this activity.

To respond to these challenges, we have taken the following steps:

- Revised our mission statement and sent it to the Board of Governors for approval during their June meeting. One reason for reviewing our mission statement was to look at ways of establishing a strong and distinct identity for the Investment Section. Our new mission statement is:

  "To provide section members with the needed content and resources to incorporate the most up-to-date information and investment decision making techniques into their actuarial, risk management, and investment management work for insurance companies, pension fund sponsors, and providers of investment products to the financial services industry."

  Your views of this new mission statement would be greatly appreciated.

- We are considering a change in our section's charter to allow non-SOA members to join. A few sections have already done this

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New Frontiers in Asset/Liability Management: Strategies to Stabilize Pension Expense

by Cees Dert, PhD.

Editor's Note: The author is affiliated with the ABN AMRO Global Equity Exposure Fund. The Society of Actuaries does not endorse investing in that fund or any other investment vehicle. Readers' response to the strategies described here are welcome.

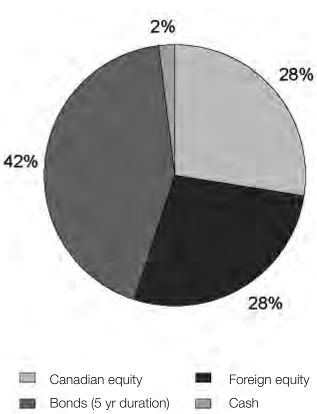
Diminished equity returns and historically low levels of interest rates are compelling plan sponsors to look at new ways of fulfilling their fiduciary responsibilities. In response, new frontiers in asset/liability management have arisen. This article will discuss strategies aimed at reducing the volatility of pension expense and decreasing the likelihood of significant funding deficits, all without increasing pension contribution rates.

The Problem—A Case Study

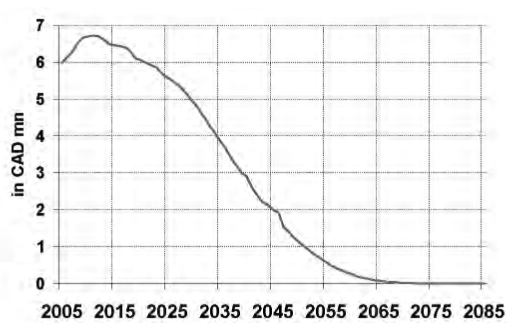
The best way to illustrate the current problem and outline solutions is through the use of a case study that I recently conducted that looked at a "typical" Canadian defined benefit pension fund. While this case study uses a Canadian plan, I have conducted similar studies in several countries worldwide with very similar results.

The current asset mix of the fund is shown below as well as projected future benefit payments.[1] The plan has a 90 percent funded ratio, and its asset mix is based on typical Canadian pension funds: 56 percent is invested in equities and 42 percent in universe bonds, with the remaining 2 percent in cash.

Current Asset Mix



Projected nominal benefit payments



Duration of benefit payments	13
Present value of liabilities	100
Market value of assets	90
Funded ratio	90 %

1) *Please note that the focus of the study was on existing pension liabilities and existing assets. Future pension expenses due to newly acquired rights and indexation were not taken into account. As such, the absolute levels of contribution would be higher still in a "real" situation. The same relative results would apply however.*

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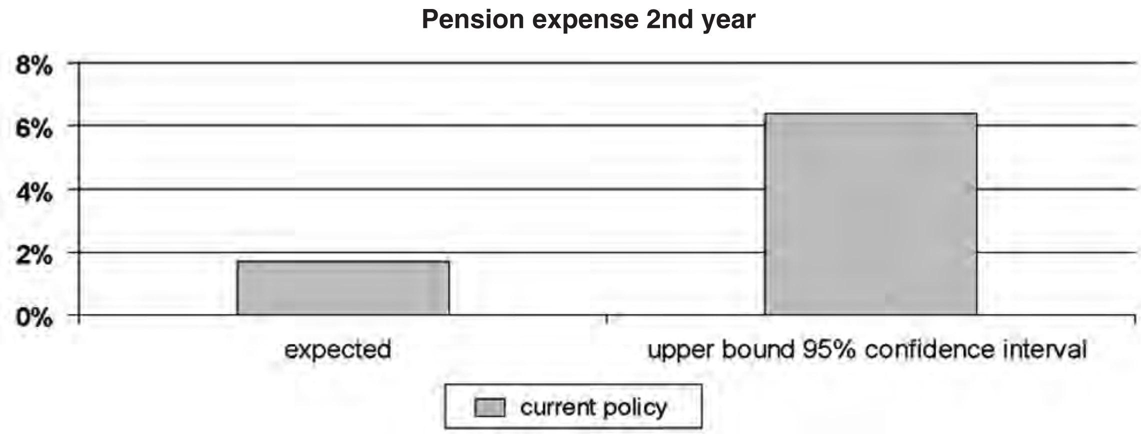
Pension expenses first year	1.8% of liabilities
Expected funded ratio at year-end	91%
Lower bound 95% confidence interval of funded ratio at year-end	73%
Expected investment return	6.4%



The stream of future benefit payments has a duration of 13 years. This implies that if interest rates decrease by 1 percent, the value of the pension liabilities will increase by 13 percent and vice versa. For future reference, note that this is quite different from the typical five-year duration of the plan's universe bond portfolio.

Using this asset mix and future benefit payment data, as well as the statistical properties of the various asset classes, numerous simulations of the plan's next two years were run under many different market scenarios in order to understand the likelihood of different pension expense levels and funded ratios emerging as the plan evolves. The results are set out in the table and chart above.

As the table shows, the pension expense for the first year is 1.8 percent of the plan's liabilities and the plan's expected funded ratio at year-end is 91 percent, a slight improvement since the beginning of the year when it was 90 percent.

However, as shown in the third line of the table, there is a 2.5 percent chance that the funded ratio will actually be 73 percent or less (i.e., the lower bound 95 percent confidence interval for the funded ratio is 73 percent). This may be more risk than the plan sponsor can actually bear, as it means there is a significant chance that the plan will have a serious funding deficiency to be made up through additional payments, a point we will return to shortly.

Finally, the table also shows that the expected investment return based on the current asset mix is 6.4 percent.

Of course, the results after one year will have an impact on the pension expense in the second year as shown in the graph above. The expected pension expense for the second year is once again 1.8 percent. However, as the graph also shows, there is a 2.5 percent likelihood that the expense could be over 6 percent under adverse market conditions. This is a very wide range of possible pension expense levels so clearly, the fund's current policy produces a high degree of uncertainty regarding the pension expense that again would probably be unacceptable to the plan sponsor.

This wide degree of uncertainty in the level of the plan's pension expense and its funded status represents a genuine risk to the plan sponsor. It is also typical of the situation faced by many defined benefit plans today, and encapsulates the "pension funding crisis" that has been highlighted in the media over the past few years. It is a real and serious problem for defined benefit plans.

Solutions

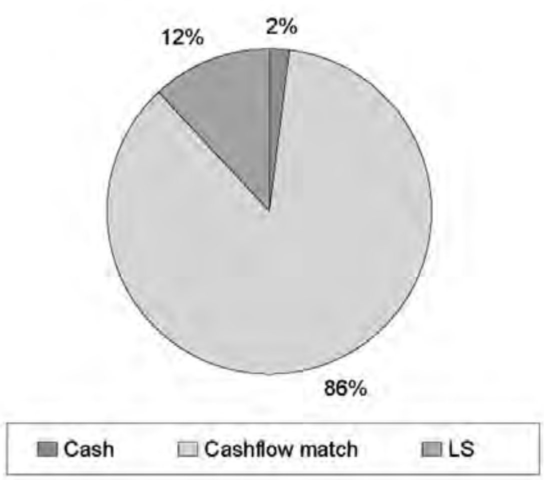
There are several different approaches one could take to reduce the fund's pension expense and funded ratio volatility. In the interest of brevity, one possible solution will be outlined in detail.

There are two well-known sources of volatility in the plan's pension expense and funded ratio: One is the difference in the duration, or interest rate sensitivity, of the fund's fixed income assets and its liabilities. The other is the downside risk inherent in the fund's equity portfolio.

To address the duration mismatch, the fixed income component of the fund should be invested in such a way that it will react in a similar fashion to the liabilities to changes in interest rates. This can be accomplished by replacing the fund's universe bond portfolio with a fixed income portfolio in which the cash flows match the pattern of the fund's projected benefit payments. This has the effect of reducing the interest rate risk.

With respect to the downside risk of the 56 percent of the fund invested in equities, a solution would be to have a smaller portion of the fund at risk in equities. But how does one do this without giving up the upside potential that equity markets have to offer?

Combination of LS and 86% cash flow matching



One approach to achieving this seemingly paradoxical result of full equity returns with fewer assets at risk is to use a carefully designed levered strategy. For this case study, ABN AMRO's Global Equity Exposure Fund was used as it gives levered exposure to global equity markets through an actively managed portfolio of listed equity index futures and options. By looking at historical performance, our studies show that one dollar invested in this strategy is equivalent to three dollars invested in a "regular" global equity portfolio. Thus, such an instrument can be used to reduce the actual dollar value of assets invested in equities without sacrificing overall performance.

The use of a levered strategy gives the pension fund appropriate equity exposure with less downside risk as there is less actual money invested than there otherwise would be in equities.

In our example, in addition to replacing the bond portfolio with a cash flow matching portfolio, we also replaced the original equity exposure with a 12 percent weighting in units of the levered strategy, and a further 44 percent cash flow matching fixed income portfolio.

The use of a levered strategy gives the pension fund appropriate equity exposure (12 percent invested in this manner is equivalent to approximately 36 percent effective equity weight) with less downside risk as there is less actual money invested than there otherwise would be in equities (12 percent versus 56 percent).

The end result of this restructuring, as shown in the chart above, is that 86 percent of the fund is invested in fixed income which is cash flow matched, 2 percent of the fund remains in cash, and 12 percent is invested in the levered equity fund. (Note: In the charts LS stands for levered strategy).

	Current	LS + 86% CFM
Pension expenses first year	1.8%	1.5%
Expected funded ratio at year-end	91%	91%
Lower bound 95% confidence interval of funded ratio at year-end	73%	82%
Expected investment return	6.4%	7.0%

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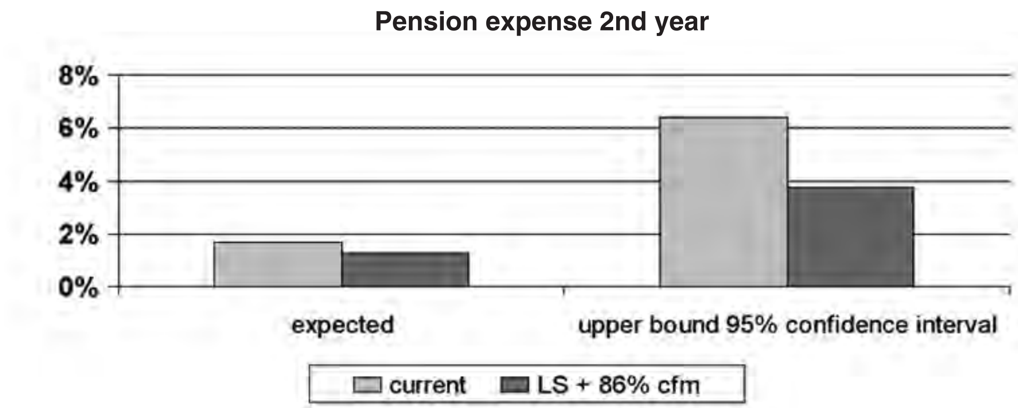

As the table above shows, the new asset mix results in a lower expected pension expense during the first year. Moreover, the lower bound 95 percent confidence interval of the funded ratio at year-end is significantly improved, growing from 73 percnet funded with the "typical" structure to 82 percent with the revised structure. Clearly, funding risk for the sponsor has genuinely decreased.

Finally, the expected investment return for the new asset mix has increased from 6.4 percent to 7.0 percent.

The graph above shows how the new asset mix benefits the pension expense in the second year. By matching the interest rate sensitivity of the assets and liabilities as well as rigorously reducing the risk of large losses on equity exposures through the use of a carefully designed levered strategy, we have managed to sharply reduce the worst-case pension expense level while at the same time increasing the fund's expected investment return.

Conclusion

Many plan sponsors are focusing on their ability to pay benefits and to smooth out volatility in pension contributions as single digit returns on assets become the norm after the heady returns of the 1990s. In response, asset managers have devised investment solutions that fit well within the framework of asset liability management. The aim is to provide investment solutions that will attain the plan sponsor's goal of meeting benefit payments while keeping funding costs at an acceptable level.

Cees Dert, PhD, is senior vice president at ABN AMRO Asset Management Amsterdam.

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- That, in order to test the desirability of any change to the conceptual framework, the project to revisit the framework should be closely coordinated with the projects that affect: banking (including financial instruments in general); insurance (including pensions and other employee benefits in general); and performance reporting. I mentioned this set of projects since, it seems to me as an outside observer, that the difficulties that the IASB and the FASB have experienced with them in the past might be directly related to the current conceptual frameworks of the IASB (and the FASB).

The Case gor Considering A Framework Change toward Behavioral Economics

1. Behavioral economics compared to the "efficient market" hypothesis. Let me start with the case in favor of "behavioral economics" as opposed to the "efficient market" hypothesis. It is an observable fact that individuals do not always act rationally in their day-to-day lives. That is not to say that they do not act consistently over long periods of time. Most modern economic theory recognizes this observation. Most modern financial institutions attempt to create added value from consistently observed customer behavior (or, in the case of new products, expected behavior consistent with that observed from similar existing products until such time as statistically credible observations can be taken concerning the new product) in addition to the value they create from their normal intermediation operations.

For the remainder of this memorandum, I will restrict myself to examples that involve financial intermediation, i.e. banking and insurance, in their broadest terms. I make the point in this document that there may be three types of behavior that appear to be "irrational" to the financial intermediary:

- those caused by rational actions based on asymmetry of information;
- those caused by temporary excesses of fear and greed; and
- those caused by individuals trading off money against other values judged to be of greater utility such as convenience, risk aversion or leisure.

The second is irrational ("excessive"). The third is rational (in the "utility" sense).

First, in deep markets in which behavior can be publicly observed. Even though "irrational behavior" (evidenced by excessive price volatility) is observed in deep liquid markets, conventional financial reporting orthodoxy seems to be to accept observed transaction prices as evidence of fair values (presumably on the basis that there is no more credible information available at the time with which to measure *intrinsic* fair value). Stock markets and property markets are two such markets that are prone to observable "overshooting" and "undershooting" of rational fair values. There is ample statistical analysis that such "irrational behavior" exists in the probability distribution functions derived from measurements of movements even in large liquid stock markets as well as in property markets. The drivers of behavior in these markets are usually explained through the oft cited factors of fear, greed and asymmetry of information.

Most modern financial institutions attempt to create added value from consistently observed customer behavior...

Analysis of the price fluctuations in these markets often demonstrates behavioral patterns that are "fat-tailed" (i.e. although they may have a similar appearance to normal distributions such as might be derived from random statistical measurement error, the number of "outlying" observations—extreme upward and downward price movements beyond two or three standard deviations—is not compatible with random statistical measurement error that would be expected from a normal distribution). From time to time, authoritative figures such as central bankers offer warnings against such "overshooting." Recent noteworthy examples are the "irrational exuberance" remarks of Chairman Greenspan and the even more recent warnings from the Bank of England about excessive upward property price movements. Chairman Greenspan's "irrational exuberance" warnings were timely; the market

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judged them to be premature. What is interesting is that, in spite of ample documented observations (in hindsight) about these large markets "overshooting" and "undershooting," financial reporting orthodoxy seems to be to accept readily observable transaction prices in these markets as evidence of "fair values" (presumably, as mentioned above, because there is no better information about intrinsic fair value).

The point is that a bank may not know what is motivating its clientele to act "irrationally."

For a time, actuaries and others attempted to deal with this observed overshooting and undershooting by using smoothed values derived from (possibly weighted) averaging of recent price observations. However, because the results of this smoothing could not be shown to be better measures of intrinsic fair value, the arguments in favor of smoothing to reduce the extent to which irrational behavior in deep liquid markets distorts financial reporting have been rejected. While I have noted this past practice used by actuaries for completeness, this paper does not advocate that such smoothing mechanisms be introduced to handle observed irrationality in financial reporting. Rather, the approach taken in this report is to use statistically credible observations of behavior throughout the recognition and measurement sections of the conceptual framework. The next section expands on this approach.

Second, in large markets in which behavior cannot be publicly observed. The same reliance on observed consistent behavior is not true of behavior that is observed in large markets for which there are not publicly available observations (especially markets that involve financial liabilities). I offer five simple, hopefully pertinent, examples of both rational behavior, irrational behavior and the "utility driven" types of rational behavior cited above for which there may be thousands, millions, or tens of millions of behavioral observations yearly that cannot be publicly observed—but which may be of relevance:

- **Bank depositors** who have made non-interest earning, or low interest earning, demand deposits may, collectively, leave large amounts in their accounts for long periods earning little or no interest. Explanations of such behavior might be:

    - The safety of having money in a bank compared to "stuffing it in a mattress";
    - The convenience of knowing that money will be on hand if and when needed;
    - Lack of knowledge about how to balance a bank book leading to excessive caution;
    - Lack of knowledge about how to make alternate interest earning investments;
    - Fear of investing in alternative investments, etc.

    Almost all of these observed behaviors cited above are likely "irrational" (in the efficient market sense). However, the customer may believe that his/her behavior is completely rational (in the utility sense). The point is that a bank may not know what is motivating its clientele to act "irrationally" (in the "efficient market" hypothesis sense). But banks can measure and monitor their customers' behavior and make money from exploiting the risk that there will not be a "run on the bank". [The roles that either banking supervision or the existence of bank deposit insurance play in avoiding "runs of the bank" are beyond the scope of this paper.]

- **Residential mortgage holders** may have the right to refinance their mortgages advantageously when interest rates fall and when the costs of refinancing are sufficiently low. Their behavior may be "irrational" in the efficient market sense, but quite rational in the utility sense.

    - The mortgage holder may feel the gain is not worth the added inconvenience.
    - The mortgage holder may not know the procedures to follow in order to refinance and may not feel that any potential gain is worth the effort to learn the procedures. Once again, the mortgage issuer may not know the reasons why its customers' behavior is irrationally "sticky"; but it can monitor the behavior and manage its affairs to make

money from its observations. [Interestingly, mortgages can be held by the originating financial institution or can be bundled into collateralized mortgage obligations (CMOs) which might then trade in observable liquid markets. As deep liquid CMO markets have developed, it is evident that the transaction prices reflect an expectation of economically irrational (or "sticky") behavior (which is rational in the utility sense). When such transaction prices can be publicly observed in the marketplace, they may be accepted as evidence of fair value. Yet, when comparable credible nonpublic observations can be made by the mortgage issuer itself (or by a service bureau that analyzes industry experience), the credible information may not be acceptable in measurement of values for financial statement purposes.]

- **Life insurance policyholders** may not surrender their insurance policies for the policies' cash surrender values and may continue to pay renewal premiums. This behavior may or may not be irrational (in the "efficient market" sense).
    - The behavior may be economically rational if the insured is aware of a deterioration in health that might show up in a medical for a new policy and prevent the desired coverage from being replaced (whether or not a formal diagnosis of such a condition has yet been made).[2] Information about the extent of anti-selection is an example of asymmetry of knowledge about which insurers can develop credible statistics over time.
    - The behavior may also be economically rational even if the insured could replace the coverage because the future likely cash build-up under a new policy reflecting its incremental new acquisition expenses would be less than the insured expects to achieve by continuing with the existing policy.
    - The behavior may be economically irrational (but quite rational in the utility sense) if, although the insured could actually benefit economically from a replacement policy, he/she does not view the potential gain as worth the time and effort to so do. The point is that an insurer may not know the extent to which its policyholders are acting economically rationally or rationally in the utility sense. But an insurer can monitor its customers' behavior as it affects both persistency and the progress of mortality and morbidity through insurance claims frequency and severity analysis to manage its affairs to make money by using its knowledge concerning its customers' collective behavior.
- **Holders of workers' compensation, unemployment insurance or long-term disability income replacement policies** that pay (say) 70 percent of pretax insured earnings may be led to claim benefits under these coverages (or to continue to claim benefits under these coverages) even when they would seem to be able to return to work and receive 100 percent of their earnings. The behavior may be rational in the "efficient market" sense or may be rational in the utility value sense.
    - The behavior might be economically rational if the insured recognizes that his/her job may be about to disappear due to economic conditions.[3] For example, workers compensation claims for "lower back soft tissue injury" among construction workers are often a leading indicator of an economic slowdown. This is an example of efficient exploitation of asymmetry of information by the insured.

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2) Often, through the selection process that occurs when an insurer underwrites a risk, an insurer gains knowledge about an insured's health. An insured may suspect that an adverse health condition exists before a policy is issued, but may not yet have had a medical diagnosis. Acting on their suspicions to purchase insurance is known as "anti-selection." A good, readily observable example of anti-selection may be that female policyholders who purchase critical illness insurance coverage are observed to be much more likely to develop MS in the period shortly after issue than should be expected–indicating that individuals can be sensitive to emerging symptoms before they become serious enough to consult a physician.

3) Such behavioral change is known in the insurance industry as "moral hazard".

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    - The behavior might be rational in the economic sense if the net income received from insurance exceeds the net income, after taxes and employment related expenses (including day care).

    - The behavior might be irrational in the "efficient market" sense if the insured values more highly the utility of leisure time gained than the income lost. Such utility driven behavior is observable statistically in unemployment insurance plans where long claims length is more pronounced among secondary and tertiary earners (especially in high income families during times when a replacement job can be obtained at will). These lengthy claims are examples of rational behavior in which the utility of increased leisure has a higher value to the individual claimant than the "economically rational" value of increased income.

- **Policyholders who purchase a segregated fund** (separate account, or unit-linked) policy that contains a guaranteed minimum death benefit and a guaranteed minimum maturity benefit may experience losses in the segregated fund that make the value of these guaranteed minimum benefits potentially very valuable. In general, the larger the difference between the guaranteed value of the segregated fund and the realizable value of the segregated fund, the more the guarantees are worth. Similarly, the closer the guarantee is to realization (measured in time to maturity), the more valuable the minimum guarantees are. Yet, policyholders can be observed to surrender the policies in spite of the potentially very valuable guarantees.

    - The behavior might be economically rational in that the policyholder needs the proceeds for other, more pressing purposes.

    - The behavior might be economically irrational, but the policyholder might have lost confidence in the insurer from which the policy was purchased and "wants out" because of the perceived utility of "peace of mind."

    - The behavior might be economically irrational reflecting the fact that the policyholder (and possibly his agent) cannot make the assessment that waiting out the period to maturity will likely produce a higher than expected gain from almost any other investment. Such a decision could still be rational in the utility sense if the policyholder has more comfort in the new alternative investment.

The income replacement example is an example of a failure by the insurer to apply "the insurance principle."[4] Insurers (including social insurers) must monitor claims experience closely to enable income replacement insurance to be properly priced and designed to reflect both moral hazard and behavioral anti-selection.

The segregated fund example may be an example of economically irrational behavior that might be triggered by the utility the policyholder derives from avoiding fear of further losses (or from satisfying anger at incurred losses to date).

The real life examples above are not cited to advance the proposition that they warrant individual special financial reporting treatment. They are produced to illustrate the more general proposition that the business of financial intermediation should operate to try to develop detailed knowledge of customers' collective behavior with respect to similar product lines, whether economically rational or rational in the utility sense. It should also monitor closely whether customer behavior is observed to change over time.[5]

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4) The insurance principle is that the existence of insurance should not, in and of itself, be sufficient to change the frequency or the severity of the event being insured against.

5) It may be neither cost effective nor possible to determine the reasons underlying any one client's behavior. It may be possible, and cost effective, to measure customers' collective behavior concerning similar products.

2. Combining temporal risk due to behavior with financial risk. In general, financial intermediaries are exposed to two types of risk: financial/economic risk and customer behavioral risk (both rational anti-selective behavior and behavior that is irrational in the "efficient market" sense, but rational in the utility sense). A financial intermediary should monitor its customers' behavior closely in order to better manage its intermediation business to see if the way the customer values utility changes over time. This is true for banking, insurance and pension operations. Financial intermediaries profit from investing monies in ways that allow a spread to be made from the difference between what is guaranteed (or expected to be paid, if greater) to the customer and what can be earned from the use of the customers' monies. To do so, detailed financial estimates are made of the timing and amount of both the monies that will be received from the customer and the monies that will be paid to the customer bearing in mind the investments made. In making these estimations, the financial intermediary will take into account the most current credible information about the behavior of its customers (including anti-selective and utility driven behavior) as well as its most current information (and views) about the financial markets and the economy. As noted above, generally, the information about the behavior of its customers is derived from statistical analysis of a collective, relevant, portfolio of customers rather than from information about an individual customer.

A simple banking example involving only customer temporal risk. Consider a simple portfolio of deposits under banking agreements that provide for perpetual renewal of the deposits until the amount in the customer's account falls below a specified minimum amount, which may be zero. In such a case, a bank will likely use its proprietary *(non-public)* statistical information about its customers' behavior in order to estimate when they will actually ask for their money. A bank could then invest the monies in risk-free securities (e.g. government bills) that pay interest or mature in such a way as to provide the monies estimated to be needed by the bank when they are expected to be needed. In such a case, the bank will have assumed customer related "temporal risk," i.e., the risk that the customers' behavior will change and he or she will ask for money sooner (or later) than expected—but it will not have assumed financial risk since it only invests in risk-free financial instruments. To the extent that the bank expects to receive monies in a timely fashion to pay for the expected withdrawal demands from its customers, it can be said to have "hedged" its deposit portfolio in the economic sense. But, current financial reporting standards may mean that it has not effectively hedged its portfolio in the financial reporting sense. This is because the value of the liability currently does not reflect the expected customers' behavior, but rather reflects the imposition on the value of the liability to the customers that, under the efficient market hypothesis, it cannot be less than the "demand deposit floor." On the other hand, the value of the government bills purchased to "hedge" the deposit portfolio fluctuates with market prices unless they are designated as HTM. This means that, although the bank has "hedged" its expected financial position, its earnings and its equity can fluctuate in ways that are a function of the differences in accounting measurement of its assets and liabilities rather than as a function of real expected financial gain or loss based on credible, recently observed customer behavior.

A financial intermediary should monitor its customers' behavior closely in order to better manage its intermediation...

Involving only temporal and counterparty risk. Of course, the bank may be able to obtain access to "hedge" accounting treatment that eliminates this discrepancy by assuming additional counterparty risk and hedging its temporal risk using derivatives (for example by investing in very short bills and purchasing longer duration swaps). A reasonable question might be why access to hedge accounting to eliminate the asset/liability measurement inconsistency financial reporting problem is only available by assuming additional counter-party (default) risk rather by investing directly in marketable risk free investments that do not merit HTM treatment.

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Involving temporal and financial (default) risk with cash instruments. Let's assume for the moment that the bank does not purchase risk-free government bills, but instead, purchases high quality, marketable, corporate instruments that are rated by rating agencies in order to have money available when needed. In this case, the bank has assumed both temporal risk (concerning its depositors' behavior) and financial risk (in this case corporate bond default risk). Once again the bank does not have access to "hedge" accounting because it has invested in real financial instruments. The earnings and equity in its financial statements are still subject to asset/liability measurement mismatch effects.

Involving temporal and financial (default) risk with bank originated loans. Let's assume for the moment that the bank does not purchase high quality marketable corporate instruments, but instead, invests in bank originated loans. As in the previous example, it has assumed both temporal risk[6] and default risk. But it has avoided the asset/liability measurement mismatch risk by purchasing an asset class that is allowed to be valued at amortized cost. (I note that the basis of conclusions with respect to the insurance standard explains that amortized cost treatment was afforded these originated loans due to reliability problems in determining fair value. Such an asset class for measurement purposes can mitigate the potential asset/liability measurement inconsistency problem for banks when deposit liabilities are subject to a demand deposit floor.)

The purpose of this memorandum is not to argue that fair value measurement techniques should be imposed on originated loans. It does observe that by reliably measuring the fair value, this asset class would be a function of both expected default rates and the shape of the interest rate curve for the appropriate quality financial instruments as well as customer loan repayment patterns. The author believes that many types of originated loans have proven capable of statistically credible observation and estimation of both loan losses and customer behavior under specific financial/economic conditions since the decision to create the asset class was made by the FASB.

Consistency of measurement of assets and liabilities is essential to the preparation of relevant, reliable, financial reporting for financial intermediaries. The preceding examples provide demonstrations of a simple concept, that asset/liability measurement inconsistencies may arise (and subsequently disappear) as a bank moves from a less risky to a more risky asset/liability management process. The least risky A/L option illustrated may not qualify for hedge accounting treatment resulting in asset/liability measurement mismatch effects being reflected in financial reports. Adding incremental risk may result in there being considerably less need for hedge accounting in order to eliminate the asset/liability measurement mismatch effect.

A Final Thought about Hedging

It seems to me that many of the problems that financial intermediaries encounter in financial reporting could be addressed by incorporating the concept of probabilities in their estimation of cash flows for hedging purposes when effectiveness is tested as well as allowing hedging to involve the use of cash instruments. More of the problems in reflecting financial intermediaries' hedging might arise because partial hedges against only one risk (say economic risk rather than behavioral risk) might not be recognized as effective. Incorporating the concept of probability (and particularly behavioral economics) in assessing exactly what is hedged and what is not might allow for resolution of the hedging problem by allowing explicit recognition for what is effectively hedged while requiring "standard" financial reporting for the portion of the risks that are not hedged.

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6) The temporal risk can be of two types in this example. First, the depositors' behavior may change with respect to the timing of withdrawals. Second, the borrowers' behavior may change with respect to patterns of repayment or refinancing.

Canadian Dollar Time Series

by Joe Koltisko

What is going on with the exchange rate, anyway? In 2002, $1 U.S. bought $C 1.60, and now in May 2005 you only get $C 1.25—that's 20 percent less! Where's it going next?

One way to answer that question is with a time series model. Let's review some terms first, and then investigate the data. An **autoregressive** (AR) time series model has the form:

$$\text{where } \Delta X = a^* (MR - X_{t-1}) + \varepsilon_t$$

where MR gives the mean reversion target, and "a" gives the speed at which the series approaches its long-run target.

A moving average (MA) time series has the form

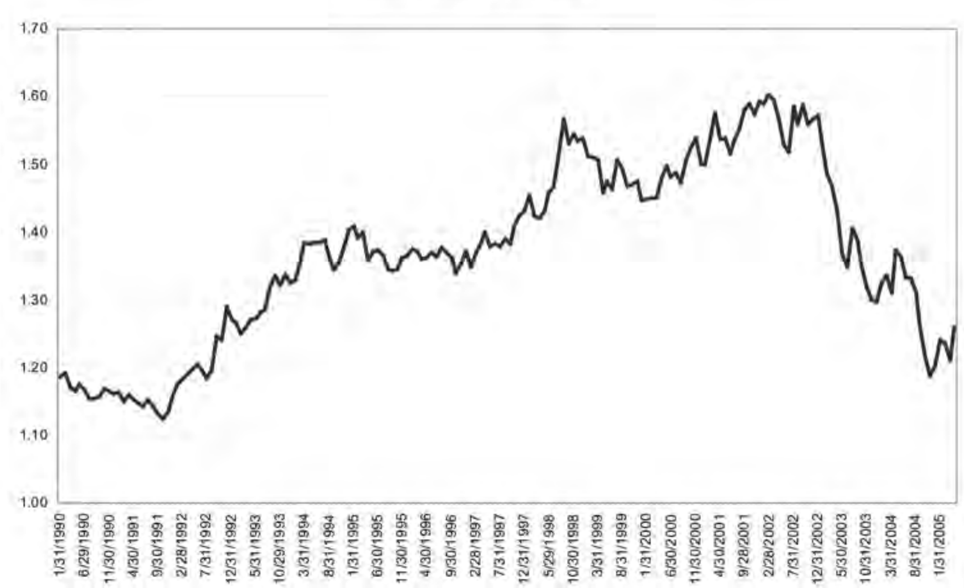
$$\Delta X = f * \varepsilon_{t-1} + \varepsilon_t$$

where "f" controls the autocorrelation of the resulting series. If f is large and negative, successive shocks are dampened, while if f is positive, shocks are magnified.

Technically, a model of the change in an economic variable is called an "integrated" (I) time series. The models may use data from one or more time periods. The series used here are ARIMA(1,1) time series, which means they are autoregressive moving average models of the change in the variable, both using one period of history.

Back to the loonie. The monthly change in the exchange rate (in absolute dollars) gives a familiar picture, similar to a seismogram. There are periods of high and low volatility. It's not obvious from the monthly change series, though, whether we're in an up trend or a down trend. To get at this, I also graphed the 12-month moving average of the change in the exchange rate (after filtering out some

Canadian Dollar / $US



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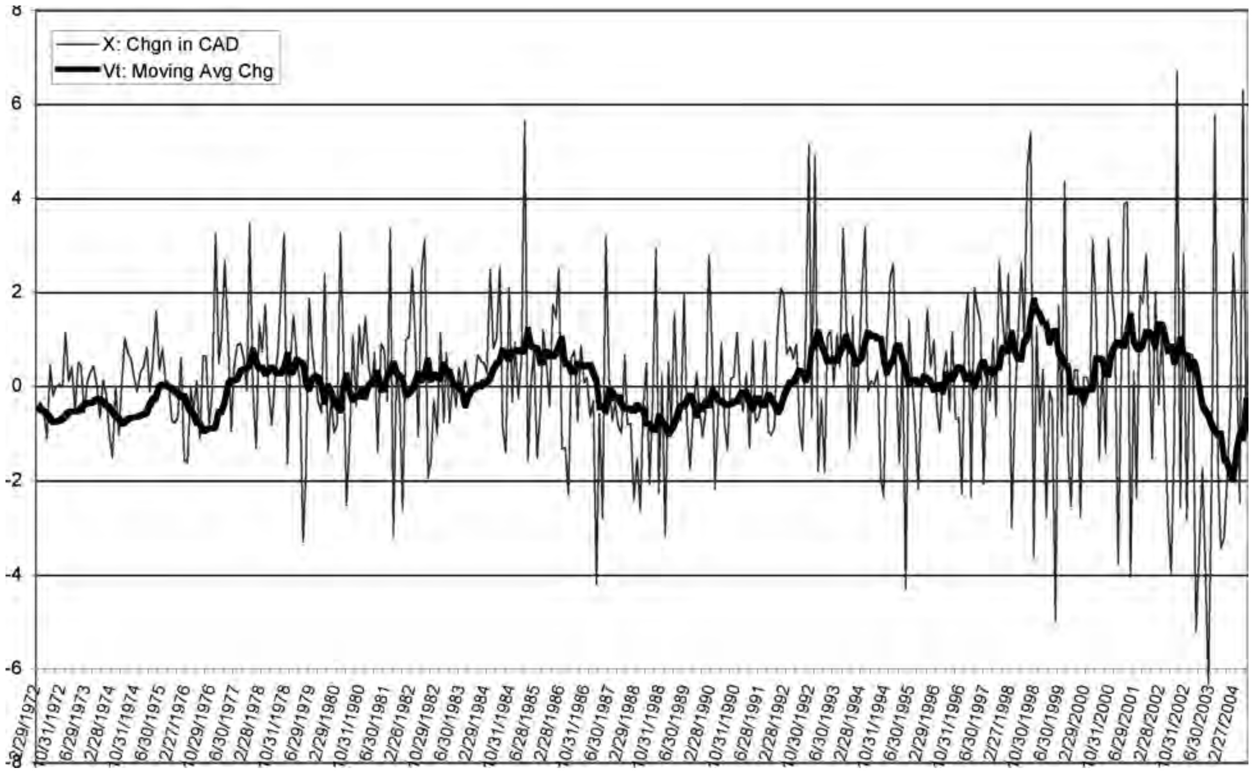
Monthly Change in CAD and Moving Average



reversion to the long-run average since 1971 of about 125).

This suggests that we could reflect the frequency and severity of trends in the CAD series by modeling the mean change as a separate process. In contrast to popular "stochastic volatility" models, this would be a stochastic mean model. The form of the model is:

$$\Delta X = V_t + a_1 * (MR - X_{t-1}) + f_1\varepsilon_{t-1} + \varepsilon_t$$

Monthly change in CAD value

$$\Delta V = a_2 * (0 - V_{t-1}) + f_2\varepsilon_{t-1} + \varepsilon_t$$

Change in mean of ΔX

That is, two autoregressive moving average models with one month of "memory." The second series, V, reverts to zero. The base series, X, experiences rising or falling trends when V is positive or negative, respectively.

I fit such a model, with least-squares minimization on the monthly data since 1971 from Bloomberg. The parameters are shown in the table on page 15. The mean reversion target, 125.16, is the average value from the data set. The series for V has a positive autocorrelation parameter, F2, which magnifies trends away from the long-term average. V also is modeled with a normal random deviate.

Once we filter out mean reversion and the process for the mean, the historical data for ΔX shows non-normal, fat-tailed residuals. To capture this behavior, the random term for X is modeled as a mix of two normal random deviates. The random term has a "low" standard deviation close to one for half of the time; the rest of the time it is over two. This fits the tail of the residuals reasonably well.

To check consistency over time, I recalibrated the model to the period after 1989. The parameters for V are comparable, which indicates that trends in the mean are not significantly different. The residual term for X shows higher volatility parameters in the more recent period. The average exchange rate was higher in the recent period, so the mean reversion target is higher as well.

Table 1: Canadian Dollar Time Series Parameters

	Since 1990	Since 1971	
A1	0.018226	0.008258	speed of mean reversion for X
F1	0.005241	(0.018521)	autocorrelation for X
MR1	136.857826	125.160000	mean reversion target for X
A2	0.068838	0.068179	speed of mean reversion for V
S2	0.233072	0.195848	std dev of V
F2	0.114252	0.056541	autocorrelation of V
P	0.667780	0.529337	chance of being in high state
S1a	1.160138	0.950646	low state st dev
S1b	2.735238	2.289211	high state st dev
X0	125.830000	125.830000	initial X 4/29/05 Value
VO	(0.800000)	(0.800000)	initial V 4/29/05 Value
max used	200.000000	200.000000	max X
min used	50.000000	50.000000	min X

As may be seen from the moving average graph, the mean term V has recovered from its historic lows of around -2, to around -0.8 as of the end of April. It's still negative, which means the model starts with the presumption that we are in a down trend. The Canadian dollar would continue to strengthen under this model. However, today's value of 125.83 is close to the long-run average.

Let's see what this model (1971 parameters) implies for the long term, and for the end of this year.

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Table 2: Distribution of CAD/$US, simulation of 1000 30-yr scenarios									
	31-Dec-05	1	2	3	5	7	10	20	30
99.5%	134.93	137.29	143.55	150.68	165.00	172.00	181.33	186.34	197.10
99.0%	133.89	135.74	141.25	148.72	158.84	169.15	178.64	181.67	185.19
98.0%	132.26	133.76	138.61	146.34	154.91	164.30	174.57	172.97	175.73
95.0%	130.04	131.23	135.09	140.60	148.03	155.29	160.44	164.85	164.90
90.0%	128.12	128.88	132.12	135.16	142.84	145.99	151.02	156.04	157.43
80.0%	125.77	125.67	126.84	129.68	133.02	136.63	138.49	145.18	145.41
70.0%	123.98	123.43	123.49	124.86	127.61	129.70	132.10	138.08	137.77
60.0%	122.65	121.56	120.79	120.51	122.00	123.66	125.37	130.69	130.93
50.0%	121.35	119.76	117.77	117.29	117.90	118.26	120.06	123.05	125.56
40.0%	119.97	117.71	114.65	113.64	113.94	113.86	115.04	116.40	118.64
30.0%	118.49	115.76	111.62	109.58	107.80	107.94	108.33	109.42	112.06
20.0%	116.54	113.71	108.08	104.73	102.16	101.29	101.72	102.77	103.80
10.0%	114.31	110.69	103.57	98.58	93.51	93.64	92.27	92.07	92.69
5.0%	112.29	107.99	98.68	94.52	87.07	87.17	82.96	83.95	83.94
2.0%	109.86	105.69	93.84	89.47	80.18	80.02	74.00	74.23	72.51
1.0%	108.36	101.89	91.27	86.47	77.63	74.86	69.02	68.10	62.03
0.5%	107.65	101.20	90.13	83.30	73.85	67.96	66.10	64.11	57.14
Avg	121.25	119.69	117.47	117.22	117.93	119.33	120.65	123.74	124.86
Std	5.43	7.11	11.03	14.06	18.52	20.48	23.28	24.89	25.31
CV	0.045	0.059	0.094	0.120	0.157	0.172	0.193	0.201	0.203

This table shows the moderate strengthening trend continuing. Average CAD levels strengthen to 117, before turning back to the assumed long run level in 20 years. It takes that long to work off the trend!

The model could also be run under other initial conditions. Suppose the mean trend variable were at 1.6, its all-time high. In that case the model output is:

Table 3: Sensitivity Test: Historical Maximum for V

	31-Dec-05	1	2	3	5	7	10	20	30
99.5%	149.71	155.14	171.83	179.78	189.12	195.02	190.45	188.90	185.41
99.0%	148.90	153.64	167.54	176.78	184.94	190.01	186.21	187.64	180.58
98.0%	145.35	151.92	164.85	173.50	178.90	183.44	180.98	181.03	176.40
95.0%	143.66	149.03	159.67	166.51	172.36	171.97	171.63	169.71	167.98
90.0%	141.39	146.66	156.51	161.07	166.21	164.73	163.32	159.89	158.32
80.0%	139.15	143.47	150.60	153.72	157.37	155.57	153.20	149.36	148.51
70.0%	137.36	141.32	147.02	149.45	150.56	149.03	146.14	140.75	139.97
60.0%	135.85	139.05	144.00	145.60	144.51	143.52	139.88	133.57	132.51
50.0%	134.89	137.36	141.05	141.70	139.85	138.51	135.02	127.04	124.69
40.0%	133.43	135.50	138.32	138.46	135.22	134.07	129.83	120.02	117.30
30.0%	131.95	133.79	135.36	134.65	130.33	127.26	123.31	112.89	109.99
20.0%	130.27	131.80	132.41	129.88	123.68	120.95	114.91	104.67	102.68
10.0%	127.73	128.96	126.94	123.49	116.39	110.89	104.23	91.41	92.04
5.0%	125.99	126.06	123.23	118.63	109.85	101.31	95.26	82.27	82.47
2.0%	123.58	124.12	119.47	113.33	98.90	90.54	85.61	73.49	72.64
1.0%	121.37	122.30	115.75	108.90	92.82	84.52	80.96	70.65	67.40
0.5%	119.48	119.86	112.43	106.04	89.30	81.77	76.74	66.11	61.55
Avg	134.68	137.53	141.34	142.03	140.28	138.09	134.34	126.75	124.97
Std	5.42	6.92	11.24	14.49	19.58	21.42	22.75	26.26	26.04
CV	0.040	0.050	0.079	0.102	0.140	0.155	0.169	0.207	0.208

Again the trend works its way off in 30 years, but not before breaking 140 in the next three years. So, the model is sensitive to the initial condition for V. It may be more appropriate to start with a point half way between the observed 12-month moving average and zero. By the time we observe the trend, it may be over.

Finally, by running the model with parameters from 1990, we get

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Table 4: Parameters Calibrated Since 1990

	31-Dec-05	1	2	3	5	7	10	20	30
99.5%	140.71	144.89	157.07	164.54	176.51	179.70	187.52	187.40	188.20
99.0%	138.93	141.54	154.40	163.35	172.63	177.56	182.95	183.04	184.64
98.0%	136.52	139.59	150.21	158.33	167.60	173.66	177.80	178.76	181.17
95.0%	134.58	136.59	145.41	150.71	160.64	164.07	170.41	170.70	173.03
90.0%	132.17	133.73	139.73	144.47	153.72	158.04	161.14	163.88	165.59
80.0%	129.01	129.50	134.26	137.25	145.53	148.81	150.08	155.02	154.91
70.0%	126.45	127.17	130.04	132.78	139.60	142.41	143.49	147.77	148.29
60.0%	124.72	124.76	126.65	129.14	134.12	136.93	137.72	141.52	142.84
50.0%	123.35	122.71	123.61	125.39	128.03	130.82	133.22	136.28	137.14
40.0%	121.71	120.84	120.08	120.78	122.58	125.81	128.03	130.68	131.02
30.0%	119.80	118.15	116.36	116.43	117.49	121.05	122.87	124.89	125.72
20.0%	117.52	115.75	112.53	111.71	111.22	113.63	116.19	119.04	119.16
10.0%	114.57	111.12	107.19	104.05	103.88	103.55	108.24	107.14	110.20
5.0%	111.80	108.08	102.15	97.90	94.80	96.80	100.22	99.14	101.23
2.0%	109.74	104.67	96.73	91.95	85.54	88.75	91.45	92.11	91.96
1.0%	107.46	101.61	93.55	86.46	81.32	85.58	84.94	86.10	86.21
0.5%	105.93	99.66	91.49	82.43	77.82	78.63	81.90	83.12	82.59
Avg	123.22	122.63	123.39	124.67	128.36	131.09	133.58	136.11	137.03
Std	6.77	8.62	13.10	15.96	19.96	20.62	20.59	21.44	21.44
CV	0.055	0.070	0.106	0.128	0.155	0.157	0.154	0.158	0.156

It's interesting that the 1990 parameters give a distribution that is "fatter" in the early years, since the coefficient of variation (std. dev./average) is greater. After five years or so, the 1990 parameters give a tighter distribution of results (as well as reversion to a higher mean reversion level).

I'll hazard a forecast: 1 $US = $C 1.23 on December 31, 2005.

This sort of model may be useful for other sorts of financial data such as interest rates. An equity price series probably should be modeled with a non-zero mean reversion target for V, to reflect long-term growth.

Are Your Scenarios on Target?

by David Hopewell

It's summertime, and the living is easy. That is, unless you have been called on to deliver a simulation for product pricing, capital estimation or valuation which is simultaneously understandable, realistic and appropriate to the task at hand. Insurance company products have increasingly become bundles of financial and life contingent guarantees with the expected profit hanging by a thin thread of behavioral expectation. Actuaries are faced with the dilemma of how to incorporate advances in insurance products and modeling technology into their work. Increasingly, this means looking at a large number of potential outcomes using stochastic simulations.

In many cases, determining the profit and risk profile of a product requires estimating the future value of a set of financial guarantees and other incentives jointly with the behavior of a policyholder faced with a complex set of incentives. Policyholder behavior is responsive to the value of various guarantees, but may also include strongly held beliefs, personal needs and advice from the broker or distant relative who sold them the policy. These two issues are individually challenging, but combined create a problem that is more complex than the valuation of mortgage derivatives and structured credit transactions, both of which have attracted massive amounts research and modeling resources. Software has evolved, but in many cases is not keeping up with the creativity of its users. Despite these challenges it is in our enlightened self-interest to minimize any avoidable loss of precision. One area where this plays out is in scenario generation and use.

Simulation problems have a simple schematic that belies the highly detailed nature of what lies beneath. In actuarial models—as in option pricing models–the input is a scenario set. The model is a set of rules that represent the function to be estimated, usually in the form of a cash-flow generator. The metrics from actuarial models can be varied and complex, covering measure of profitability, income, risk and surplus. The metric from an option model (see Figure 1) is a simple average, no matter how complex the underlying function.

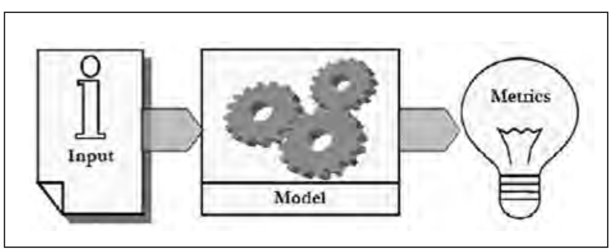

Figure 1

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The common decisions for any scenario generation project include the selection of the sample set that serves as the basis for the scenarios, the assumed distribution(s) for parametric approaches or statistical sampling technique for non-parametric approaches and the method of associating marginal distributions. Once those decisions have been made and the process for generating scenarios with those qualities is complete, the final step is to determine parameters that best match the important features of the sample set. That step is called calibration: where theory meets reality.

Risk neutral asset pricing is one of the great advances of modern finance and a common language market participants share.

When Worlds Collide…

Most of us are familiar with the two broad approaches to scenario generation: risk neutral scenarios are used to price options and guarantees, while real world scenarios are used to estimate the potential outcomes or probability distributions of future observable events. Risk neutral asset pricing is one of the great advances of modern finance and a common language market participants share. The great value of risk neutral analysis to the actuarial community is that it provides a theoretically supported shorthand technique for valuing assets by observing the price of other assets. This makes it worthwhile to master, as we develop and often hedge financial guarantees seen nowhere else on earth, but it's important to remain aware of the hazards in determining the "implied" values for uncommon assets from observations of more common assets.

The first step in generating risk neutral scenarios is extracting important distributions implied by observed prices. If we knew what those distribution were and could look deeply enough at the market, our calibrated model would produce scenarios that perfectly reproduce the prices of all observable market instruments, which therefore is highly likely to produce the correct price for a new asset. So why don't we just do that and go home early? The answer is as simple as the solutions are not; models are not comprehensive or accurate enough to reflect reality. Most observed asset prices contain components (usually lumped together and called liquidity premium) that make it difficult to isolate the distributions we are interested in and, worst of all, the implied future distributions generated from different sets of observed asset prices are often inconsistent and mutually exclusive!

An example is the difference between implied forward rate distributions derived from interest rate caps/floors and swaptions. An relatively simple interest rate model such as the Brace-Gatarek-Musiela (BGM) model can easily be calibrated to perfectly reproduce the price of at-the-money caps and floors, but is not likely to do a good job of pricing swaptions, especially if they are out of the money. More complex models reduce but don't eliminate this issue, since it is a feature of the observed market seen through the lens of existing models. The calibration instruments do not contain more information than is needed to set their own price.

The same is true of the Black-Scholes derived, implied volatility model for equity options, which may succeed in matching the observed prices of vanilla options, but also gives different values for more complex structures. The most variation in implied prices is frequently seen in strongly path dependent options, where the value ultimately depends not just on what values the underlying achieves, but when. One way this is dealt with is to increase the size of the sample—the market instruments used—and relax the fit (minimizing the sum of squares between actual and model pricing). But this has limits, too. There may be no instrument that contains the higher order information required to accurately value a path dependent insurance guarantee: the market may not be complete.

Here is where reality trumps theory. In the complete market of theory, prices are unique and profit-seeking traders assure that the same risks trade at the same price, no matter the package. In an incomplete market, prices are not unique. There may be correctly more than one appropriate price for an unobserved asset, such as an insurance financial guarantee, because many available strategies with similar cash flows have different expected returns. There is no roadmap to define the best strategy or whether a strategy tests best depends on the model and calibration used to test it. The problem is circular and solving it is art as much as science.

There are various approaches to the problem, and all have their place in an insurance company setting. One way is to use a more theoretical approach—chosen for tractability. The primary theoretical approach uses the lognormal distribution, with a fixed or time varying volatility for equity and fixed income, and a fixed linear correlation between the two. Calibration is relatively simple if simple instruments are chosen, but is more likely to be unstable since future change in volatility and correlation will depend on the market path.

The volatility and correlation structure observed in the current period may be extended as an assumption for future periods. However, this approach is likely to give optimistic estimates when compared to market consistent calibration methods for out-of-the money options. The latter approach can be extended with volatilities that vary by index or rate level as well as by substituting copulas for correlations, however the complexity increases rapidly.

Another approach is to use an alternative model that more accurately reflects the market-implied distributions of observed instruments with fewer parameters. Unfortunately, few alternative models have a closed form solutions for option prices. The Heston GARCH model is an equity option model with a closed form solution that offers a better current and future period fit than Black-Scholes option implied volatility (Heston and Nandi 2000).

If even more realism is required, i.e., combining dynamic real world policyholder behavior with option valuation, much of the financial theory focused on giving convenient answers under simplifying assumptions is lost, and prices need to be determined from first principles of simulating the best strategy and the cash flows expected from it.

Get Real…

Since most of the theory for pricing options has focused on the risk neutral world, it may come as a surprise that options can also be priced entirely using real world models. Consider a delta hedge on a European option. The Black Scholes value of the option can be matched (in the limit) with a risk neutral simulation. It can also be matched (in the limit) with a (simplified) real-world simulation, where in addition to the option premium and payoff, a delta hedge strategy is simulated. When the real-world payoff of the option and the strategy are combined, the theoretical price is obtained. Each path has precisely the same net cost, which equals the initial price of the option. This replicating strategy approach only works if the real world volatility, dividend and interest rate assumption match, but it proves the point; risk neutral pricing is a convenience used when certain simplifying assumptions are acceptable. As those assumptions become less acceptable, direct simulation of the hedging strategy becomes necessary.

The primary simplifying assumption is that the market is complete and any participant who chooses can be relieved of any risk for the same price as any other participant. Writers of unique path dependent options care about this assumption because the market is not complete with respect to their risks. No model or calibration technique can avoid that and so those seeking the best answers may have to return to the real world. Ironically, in the real world the way is more uncertain. Like a giant X in the middle of an empty map, our target may be apparent, but the path and hazards along the way hide in wait and challenge us to overcome them. At first, the journey is easy and the steps resemble those of the risk neutral approach. There is a sample of outcomes that define the target. In the real world the sample is observable history rather than observable market prices. Here is the first challenge. Which history is appropriate and when?

The Heston GARCH model is an equity option model with a closed form solution that offers a better current and future period fit than Black-Scholes option implied volatility.

There are many facets of markets: countries, time periods, instruments, or in the case of indexes, actively managed samples of instruments. There are also markets that have not survived, where claims on assets if not the assets themselves have been destroyed. Since we are generally looking at outcomes that are relevant to our management, shareholders and regulators, it is appropriate to ignore markets that don't survive and keep in mind that our results are an expectation conditioned on that survival. That conditioning is sometimes called survivor bias.

The goal of a real world simulation is to estimate the probability of future outcomes. This usually begins by comparing history to a model—many of

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which are inspired by Markowitz—and decompose historical returns into a risk free return (the return on low duration government bonds, for instance), standard deviation assuming a lognormal evolution of prices, and risk premium. Those parameters are based on a time period that is deemed likely to reflect the simulated period, usually by ignoring historical data before some point in the past.

The major choice is deciding whether the market moves in absolute increments or increments that are relative to yield.

For instance, in 1992 the English pound left the European Monetary Union under pressure and in 1997 the Bank of England achieved operational autonomy. Periods including 1992 probably won't be repeated, while in 1997 consistency of policy was achieved and seemed likely to persist. Calibrations to the U.K. Gilt yield curve start to look similar after 1995, so that may reasonably be the start of the sample calibration period. In the United States, there have been several distinct regimes such as the Volcker Fed period of active inflation fighting, and the Greenspan Fed that has alternated between inflation fighter and liquidity provider. More formal methods, like maximum likelihood estimation, can also identify periods that are not like the recent past, although they do not prove anything about the present.

All these methods rely entirely on the past. But the United States and maybe much of the world is undergoing a shift: an aging population with needs shifting from consumption to saving is combining with the increased productive capacity of globalization in a way that is very likely to change future risk premiums. Capital that was once dear has become relatively cheap, asset prices higher: the risk premium has fallen. Ways of thinking about risk have changed. Most investors now invest against a benchmark that is not cash. In fact, a professional investor's benchmark is a risk free asset, since the risk premium and standard deviation are measured against it. The rise of the benchmarked investor calls into question everything we believe about risk premiums. Prices of U.S. government bonds, in many cases, move inversely with risky assets, thereby acting as "negative risk" assets. That implies that cash indexed investors, such as hedge funds, might be willing to accept a negative risk premium on at least one type of positive standard deviation asset, the U.S. Treasury bond, because of the way it combines with their other holdings. The dynamics of the U.K. Gilt curve also suggest that the highest standard deviation long bond may not generate the highest return over time. Is there reason to believe in a systematic standard deviation linked risk premium when capital is not the constrained asset and cash is not a universal safe haven?

That caveat aside, there are several approaches for taking observed markets and turning them into scenarios that can be used to price financial guarantees. The first is to use the same sort of models frequently used to generate risk neutral scenarios. The major difference is setting the risk premium to some value other than zero, and using the historical volatility of the market rather than deriving a volatility that matches market prices. The major choice is deciding whether the market moves in absolute increments or increments that are relative to yield. Naturally, actual yield curve movements are a combination of both.

Another approach is to use a minimally parametric approach such as that of Rebonato (2003), which simulates yield curve mechanics by sampling the actual yield changes and local curvature from historical data for some period, then jumps stochastically to another time interval. Calibration is limited to picking a time period and jump parameters, and determining the weight each local curvature applies to its associated yield curve point. This model could very likely be extended to other yield curve exposures, such as risky bond spreads or yields.

There are many equity models that reproduce some features of historical equity returns in the United States, such as the volatility of lognormal standard deviations, the correlation of standard deviations with changes in price and the less than linear increase in variance of equity prices with time. There are the regime switching lognormal model and stochastic log volatility model associated with the C-3 Phase 2 effort of the AAA. There is a model described by Ed Thorpe (2004, 2005) using a GARCH approach combined with the Students T distribution under which the 1987 crash is not an impossible outlier. A model no doubt could be constructed along the lines of Rebonato (2005) described above with equity indices substituting for yield curve points.

Most convenient is a model like Heston's (2000) GARCH model for equities that has both a closed form solution for European options, given a historical equity path, and can be used to estimate future risk neutral parameters, such as market implied volatility. That allows for a mixing of the real world and risk neutral pricing by using the real world path to give a best estimate of the risk neutral parameters that allow for the simplified risk neutral calculation. This sounds complex but is simpler than directly defining the evolution of risk neutral distributions over time.

And how can the modeler be sure that extraordinary efforts are rewarded? Option pricing models at least allow for the reproduction of the input market prices as a test for effectiveness. Success at pricing out of sample market observations, improved tracking over time and more stable parameters are a bonus for doing extra design work. Real world models can be tested for statistical similarity to the input set, but this has to be done with the higher order detail in mind.

Full Circle…

Scenarios of all kinds require careful calibration to achieve their intended result. The process starts by creating a clear picture of the important features of the scenarios. A model that supports those features has to be used. Then a sample set of observable prices or data is identified and criteria for what constitutes a good enough match is determined. Imposing a distributional assumption on scenarios may substantially reduce the richness of distributions and produce major differences in the prices of some types of insurance company financial guarantees. This can be reduced by more sophisticated models or by using statistical techniques that don't assume distributions, but even the most sophisticated approaches can't overcome the data limitations of incomplete or contradictory observations. In an incomplete market, the true price of an unobserved security can't be known with certainty, but its sensitivity to the unknown can be systematically reduced once it is understood.

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Earnings Focused Asset-Liability Management

by Barry Freedman

This article is based on research by the author for the purpose of completing his professional development project as a partial fulfillment of his FSA requirements. The views expressed in this article are those of the author alone and do not reflect the asset-liability management strategies of his employer.

Introduction

There are two main techniques for evaluating the financial impact of interest rate movements on insurance companies: duration measures and computer simulations. In many ways these approaches provide complementary viewpoints.

The duration approach to evaluating interest rate risk is based on a relatively simple theoretical model.[1] The basic goal of the duration approach is to evaluate the impact of interest rate movements on the market values of assets and liabilities. Although the model has evolved since its description by Redington, its fundamental properties have remained unchanged—this model is essentially based on market value measures. On the other hand, earnings (GAAP, statutory and tax) are based on book value measures, such as net investment income and change in reserves. The duration approach, even at its most complicated, can therefore only approximate the impact of interest rate movements on earnings.

In contrast to the duration approach, computer simulation based asset-liability management (ALM) models typically take a large amount of asset and liability data and apply borrowing and reinvestment strategies to project financial experience. Although these simulation models will often produce market value outputs, their focus tends to be on a balance sheet and income statement presentation. In other words, instead of concentrating on a duration model, computer simulations can be said to have a book value focus.

Given the complementary nature of the existing models, what benefit is there in a new model for understanding the financial impact of interest rate movements? The answer to this question lies in the nature of theoretical models as compared to computer simulations.

Computer simulations tend to take all of the information available for inputs, use arbitrarily complex assumptions, and produce reams of data as output. These models attempt to approximate reality by using as much information as is available. On the other hand, these models tend to be extremely time

1) See, for example, chapter 3 of Panjer (1998).

consuming to maintain, and produce no simple explanation of their results (if correct) or the source of errors in their results (if incorrect). Invariably, we turn to theory in order to convince ourselves of the sensibleness of simulations' results.

In contrast, theoretical models attempt to approximate reality by using a few well-chosen, but dramatically simplifying, assumptions. These models are therefore able to organize the mass of inputs into just a few aggregate items. This creates a simpler understanding of the nature of the model results, and therefore, hopefully, of the real world. On the other hand, a theoretical model will generally have few outputs. For example, for all its strengths, the duration approach is limited to its market value focus.

This article discusses an attempt to build an earnings focused, theoretical model to complement the two approaches discussed above. A more mathematical development was presented recently at the 2004 Investment Actuary Symposium and AFIR Colloquium.[2]

Why Should ALM Focus on Book Value Measures?

In comparing approaches there is a temptation to over-simplify and say that the market value focus captures the underlying "true" economics, while the book value focus is "only" based on accounting. In reality, of course, the situation is more complicated. On a practical level the book value focus is the preferred focus of regulatory agencies and equity analysts and, therefore, of senior management. Furthermore, balance sheets are often managed to book value specifications; for example, there may be a desire to hold the book value surplus at some multiple of risk-based capital.

Also, note that the fundamental goal of a market value based ALM model is to measure the potential volatility of the market value of surplus. The market value of surplus is typically calculated by subtracting the present value of liability cash flows from the market value of assets. An alternative calculation, however, is to define the market value of surplus to be the present value of projected portfolio earnings.[3] An ALM model that produces earnings as output can therefore also be used to evaluate market value of surplus.

Finally, it is important to recognize that general account cash flows are often determined by book-value calculations. An obvious example of such a cash flow is federal income tax, which is based on tax reserves and asset book value calculations. Another example (illustration follows) is distributable earnings. Book value based cash flows can have a profound impact on traditional duration target calculations. Consider the following two cases:

Case 1: *Simple fixed liability cash flows*
Given a set of liability cash flows with no optionality (e.g., a portfolio of GICs or payout annuities), one simply calculates the liability duration and sets the asset duration target equal to the liability duration.

Case 2: *Include distributable earnings as a liability cash flow*
Any portfolio of assets and liabilities will throw off distributable earnings. Assume that these distributable earnings are in fact distributed. This represents a real cash flow out of the general account and should be included in the liability duration calculation. In order to estimate the size of these cash flows a simple ALM simulation model can be built, using the current assets and liabilities as inputs, and the distributable earnings under various interest rate scenarios can be calculated. These interest sensitive cash flows can then be added to the liability benefit cash flows and the liability duration can be computed. Unfortunately, *this procedure leads to a liability duration that is exactly equal to the current asset duration, whatever the current asset duration is.*[4] In other words, a careful calculation, which includes book value based cash flows, can lead to a nonsensical tautology when attempting to find a target asset duration.

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2) See Freedman (2004). This paper is also available at http://afir2004.soa.org/afir04_6.pdf.

3) These two methods can be shown to yield equivalent results, provided one uses the appropriate interest rates in the present value calculation. See Girard (2000).

4) This can be seen in a simple spreadsheet by assuming a flat yield curve, and projecting distributable earnings for any simple portfolio. The market value (and hence duration) of liabilities plus earnings is calculated using an interest rate equal to the asset yield rate.

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A Book-Value Measure of Asset-Liability Mismatch

In each of the two cases above, what is the risk minimizing asset portfolio?[5] The risk-minimizing portfolio in Case 1 is clearly the classic cash-matched portfolio (dedication). To find the risk-minimizing portfolio in Case 2, consider the following points:

- If distributable earnings are in fact distributed, then the book value of the assets will be constrained to be equal to the book value of liabilities.[6]

- If the asset portfolio is, therefore, designed so that the asset rollover is equal to the liability rollover, then the book value of assets will naturally equal the book value of liabilities and no reinvestment or borrowing will occur. Hence, this asset portfolio is the risk-minimizing portfolio.

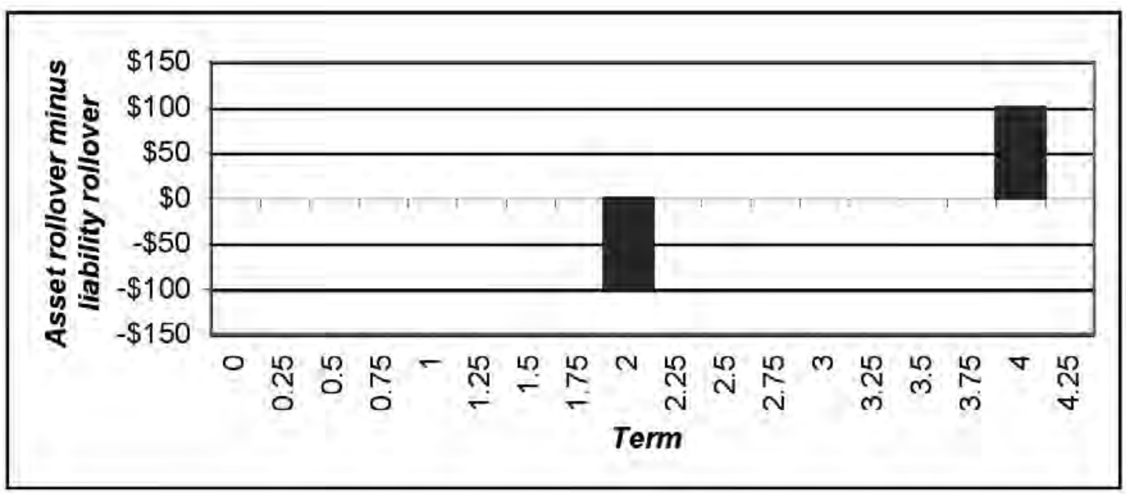
Given the risk-minimizing portfolio, the asset-liability mismatch can be defined as the distance from the risk-minimizing portfolio. That is, define an asset-liability mismatch function to be the projected asset rollover minus the projected liability rollover. This asset-liability mismatch measure is called gap analysis and is commonly used in the banking industry.[7]

A simple example can help elucidate the kind of information contained in the gap analysis measure. Consider a portfolio in which the only liability is a $100 coupon paying GIC with a 2-year term, and the only asset is a $100 corporate bond with a four-year term. The asset-liability mismatch function is shown in Figure 1.

There are three points that can be made about this asset-liability mismatch measure:

1. The asset-liability mismatch shown in Figure 1 is a snapshot. As time progresses, this graph will change. For example, if no other liabilities are added to the portfolio and no asset action is taken, then the mismatch function above will drift to the left.

Figure 1: Gap analysis asset-liability mismatch function



5) Here "risk minimizing" means the portfolio of assets that allows us to assume no future reinvestment or borrowing, hence no exposure to changes in future interest rates.

6) The book value of liabilities will depend on the context, but can be more complicated than the liability reserves. For example, in a GAAP context the book value of liabilities is the GAAP reserve minus any deferred tax asset and DAC asset, etc. Capital may or may not be included.

7) I would like to thank Jean-Francois Boulier for bringing to my attention the fact that the asset-liability mismatch function I discuss in Freedman (2004) is identical to gap analysis. More details on how gap analysis is used in banks can be found in the report of the Basel Committee on Banking Supervision (2004).

2. This asset-liability mismatch function emphasizes the timing of potential future earnings volatility. In the case of Figure 1, it is clear that interest rate movements will not impact earnings over the next two years. At the end of year two, however, the portfolio must either sell assets or write new liabilities, and the earnings beyond year two will be impacted by the interest rates at year two.

3. This asset-liability mismatch function does not provide any information about the overall level of earnings that can be expected. In the case of Figure 1, the mismatch function will not change regardless of whether the asset earns 50 or 100 basis points more than the liability credits.

Before proceeding, it is important to mention some of the limitations of this measure:

"[G]ap analysis ignores differences in spreads between interest rates that could arise as the level of market interest rates changes (basis risk). In addition, it does not take into account any changes in the timing of payments that might occur as a result of changes in the interest rate environment. Thus, it fails to account for differences in the sensitivity of income that may arise from option-related positions."[8]

These limitations, while important, are not overwhelming. This type of analysis is clearly not suitable for all asset portfolios and all types of liabilities, but for portfolios in which cash flow optionality is not significant, (e.g., payout annuities backed predominantly by non-callable bonds) gap analysis is very appropriate and also much less work than a full-fledged simulation.

An Earnings Focused ALM Model

From the perspective of asset-liability management, not all earnings are created equal. In particular, it is appropriate to separate earnings that will vary with future interest rate movements from those that will not. Already discussed is the fact that if the gap analysis measure is zero along the curve, then future earnings will be insensitive to interest rate movements. This section will focus on the level and volatility of earnings that arise due to a nonzero gap analysis measure.

Continuing the example above, recall that initially a two-year GIC was backed with a four-year bond. Assume now that at the end of year two, when the GIC matures, a decision is made to raise the required cash by issuing a floating rate liability. Future earnings can then be projected. There are three main sources of these earnings:

1. Credit risk. The liability will credit a floating rate (for example, 90-day LIBOR + 10 bp) based on the credit quality of the issuer. The bond backing the liability will earn a spread above LIBOR (for example, LIBOR + 45 bp) based on the credit risk of the asset.

2. ALM risk. The floating rate liability is backed with a two-year bond. The current earnings impact of this mismatch is equal to the current difference between the two-year LIBOR swap rate and the current 90-day LIBOR rate (for example, 100 bp).

3. Results of previous ALM decisions. In this example, the two-year bond backing the floating rate liability was actually purchased two years previously as a four-year bond. The coupon rate on this bond is therefore not likely to be the same as the current two-year rate. The earnings pickup in this case will be based on a combination of historical interest rate movements and historical yield curve shapes. (For example, the bond might have a coupon rate that is 60 bp above the currently available two-year coupon rate for an asset of similar credit quality.)

In this example the current earnings from the portfolio are:

35 bp (credit risk) + 100 bp (ALM risk) +
60 bp (Prior ALM) = 195 bp.

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8) See page 28, Basel Committee on Banking Supervision (2004).

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From an ALM perspective, the most interesting of these earning sources is clearly the 100 bp from ALM risk since the other sources of earnings will not be affected by interest rate movements. Note also that while the 95 bp from credit risk and prior ALM decisions are dependent on the details of the portfolio, the 100 bp from ALM risk does not depend on the details of the portfolio. It therefore seems that for the purpose of evaluating the risk-reward tradeoffs of ALM risk one does not need to carefully model the details of a specific portfolio; instead the problem can be treated generally and one can develop simplified earnings based risk and return measures.

In fact, the previous example can be generalized and evaluated mathematically.[9] Defining the earnings that emerge from ALM risk as "mismatch-earnings," it is possible to show that if one knows 1) the current and future gap analysis measure and 2) the current and future yield curve, then the future mismatch-earnings can be projected (given a series of simplifying assumptions). Below is a closed form formula showing projected mismatch-earnings:

$$e_{mismatch}(t) = \int_0^\infty dt'\,\delta_t(t')C_t(t') + \int_0^t d\tau \int_{t-\tau}^\infty dt'\,\delta_\tau(t')\left(\frac{\partial}{\partial t'} - \frac{\partial}{\partial \tau}\right)C_\tau(t')$$

where,

- $e_{mismatch}(t)$ is the level of earnings at future time t due to current and future asset-liability mismatches.
- $\delta_t(t)$ is the gap-analysis mismatch function at future time *t*.
- $C_t(t)$ is the yield curve (coupon rates) at future time *t*.

A brief explanation of the mismatch-earnings projection formula is as follows. The first term in the calculation of $e_{mismatch}(t)$ represents the earnings at time *t* from the asset-liability mismatch chosen at time *t*. The second term represents the earnings at time *t* from the asset-liability mismatch chosen from times 0 to *t*. In particular, the term $\frac{\partial}{\partial t'}$ represents the earnings arising from the shape of the yield curve from time 0 to *t*, while the term $\frac{\partial}{\partial \tau}$ represents earnings arising from yield curve shifts from time 0 to *t*.

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9) *See section 2 of Freedman (2004).*

Further explanations and analysis are given in Freedman (2004).

Using this formula it is clearly possible to calculate the expected value and standard deviation of future mismatch-earnings due to a series of stochastic interest rate scenarios.

Conclusions

Admittedly the mismatch-earnings formula previously shown does not have the clean and obvious form that one would like in an analytical model. However, there are two key results that can be derived from the existence of this formula:

1. Gap analysis is a useful framework for understanding a portfolio's exposure to earnings volatility.

2. One does not need a full-blown simulation model to understand the impact of interest rate movements on a portfolio's earnings. Instead the focus should be on deriving simple models (either analytical or spreadsheet) to project the expected earnings and volatility of earnings due to ALM risk (ignoring the other components of earnings).

Clearly there is much work to be done, but I am hopeful that earnings focused asset-liability management is both possible and useful.

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Modeling Economic Series Coordinated with Interest Rate Scenarios

by Steven C. Siegel, SOA Research Actuary

The SOA's Committee on Finance Research recently made available the results of a research study that explores economic series and provides an Excel-based tool for generating future economic scenarios. The study, which was jointly sponsored by the SOA and CAS, was conducted by the team of Kevin Ahlgrim of Illinois State University and Stephen D'Arcy and Richard Gorvett, both of the University of Illinois.

The genesis of the study was a request for proposals issued by the sponsoring organizations in May 2001. Both sponsoring organizations issued the request for proposals due to the motivation generated by the importance of this topic to the actuarial profession and the broader insurance community.

In particular, the generation of scenarios is critical for regulatory, rating agency and internal management tests of an insurer's potential future operating conditions. An example of a direct application of scenario generation is cash flow testing to assess an insurer's cash position over a wide range of future economic and financial possibilities. Scenario generation is also critical for Dynamic Financial Analysis (DFA), an area of continued interest by many within the actuarial community.

Besides the essential need for generation of economic scenarios in these settings, the sponsoring organizations were also deeply interested in further advancing the state of the art in scenario modeling. Specifically, the interaction of economic variables including interest rates, equity price levels, inflation rates, unemployment rates and real estate price levels among others is an aspect that bore considerable interest. Although previous models may have performed very well for any one of these economic variables, the goal in this effort was to realistically model the correlation of all of them. Given this lofty charge, the model resulting from the study should be viewed as a demonstration of concept, rather than as a standard for use by actuaries or to supplant the use of other models.

Key aspects of the study included a comprehensive literature review of relevant articles, derivation of the underlying theoretical calculations to be generated by the model, and development of the Excel workbook to program the calculations. Reviewers representing both the SOA and CAS provided feedback to the research team throughout the course of the study. This included suggestions for appropriate articles for the literature review, guidance on issues that would be of specific interest to insurance companies such as the New York 7 tests, and the choice of the particular interest rate model.

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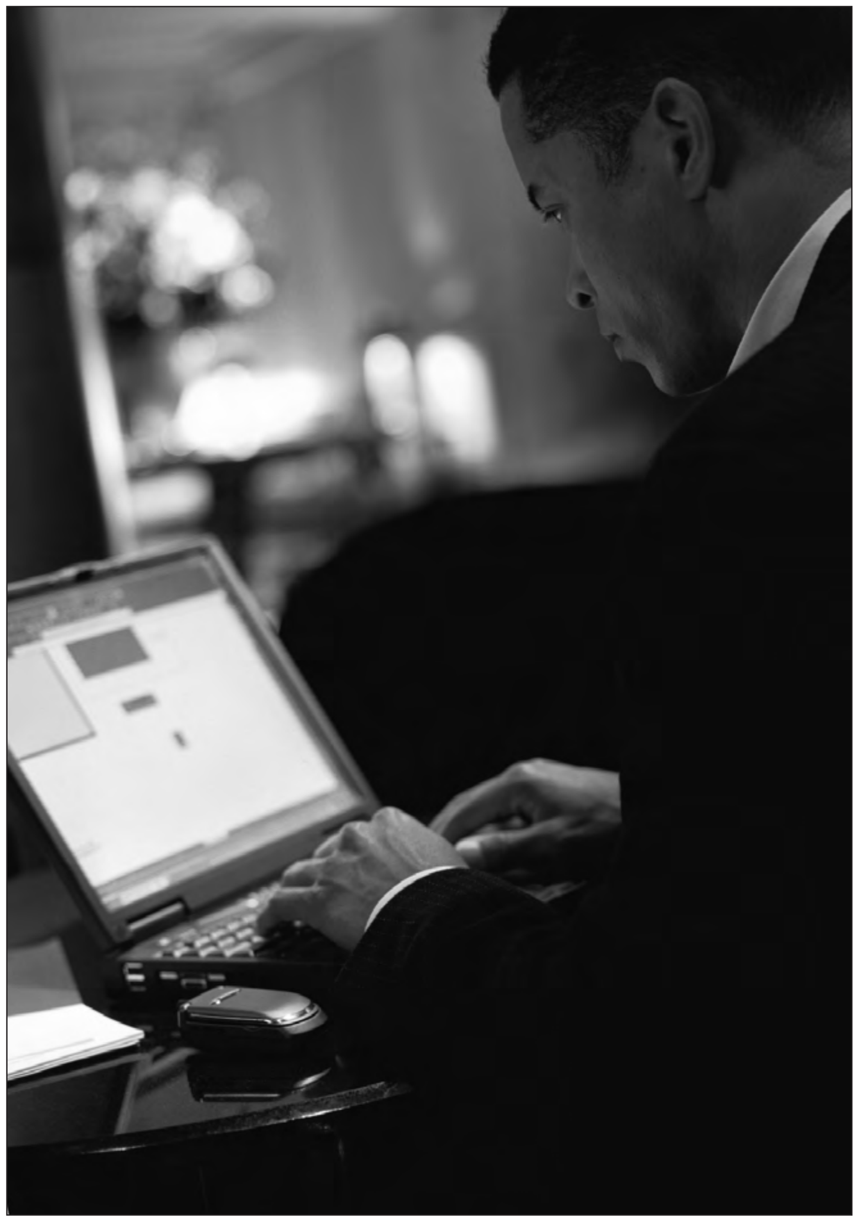

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The complete material can be downloaded from the SOA Web site in the Finance Research projects section at: *http://www.soa.org/ccm/content/areas-of-practice/finance/mod-econ-series-coor-int-rate-scen/.* Because of the complexity of the calculations and the statistical nature of the information outputted, an Excel add-in, @RISK, is needed to utilize the workbook. @RISK is available for purchase at *www.palisade.com*. The workbook includes default values of appropriate parameters. However, these can be changed by the user for purposes of updating for new or additional data, sensitivity testing of parameter values and other user needs.

For users that do not wish to purchase @RISK, the research team has included an appendix in the form of an Excel spreadsheet that contains hundreds of scenarios of financial and economic variables generated as output from the model. The appendix, which is approximately 30 megabytes, may either be downloaded from the SOA Web site or is also available as a CD-ROM by writing the SOA office.

As with all projects, the SOA Investment Section Research Team would love to hear your feedback on this project and thoughts for future efforts. Please feel free to contact me at 847-706-3578 or *ssiegel@soa.org* with your ideas and suggestions.

Chairperson's Corner

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and our primary motivation for this is to recruit investment professionals to join our section. We think this would bring significantly more value to our current members, allow for more breadth and depth of session content at meetings, and allow actuaries to have greater visibility with investment professionals.

- Revising the Investment Actuary Symposium. This seminar will be held in New York in the spring of 2006 and we will start our planning process for this symposium within a couple of weeks. This symposium will have multiple tracks of sessions that will appeal to a wider range of attendees than we have had in the past, such as portfolio managers, risk managers, ALM practitioners and others who have a need for up-to-date information on investment related topics. We view this symposium as our signature event for the year and we will be interested in recruiting members for speaking at this event!

Michael J. O'Connor, FSA, MAAA, is a consulting actuary with Towers Perrin in Minneapolis, Minn. He can be reached at Mike.OConnor@towersperrin.com.

Some of the key issues that we are working on include:

- Getting more input from our members, so we are in the process of developing a survey (yes, another dreaded survey!). This will be a key tool that we will use to get input from all of our members.

- Developing the value proposition for non-SOA members to join our section and determining what that might mean for our current members, for future activities, and so on.

How can you help?

There are a variety of ways that you can help respond to these issues! In one way or another, we need more volunteers for committee work, for research activities, for session ideas, and definitely for speaking at the many sessions that we sponsor. With our section's increased responsibilities, we need more volunteers to help us.

This is clearly a time of transition for the Investment Section, and we welcome your input, thoughts and volunteerism to help us meet the many challenges that lie ahead of us. Thanks for your support.

SOA Investment Section Prepares for Annual Meeting 2005 in NYC

ANNUAL MEETING & EXHIBIT SOA05

While most of us were thinking "spring," the SOA Investment Section was busy planning our fall SOA Annual Meeting Sessions. As you know, the meeting will once again take place in New York City. We have a very exciting program for you this fall and hope to see many of you in the Big Apple.

Our slate of topics begins on Monday, Nov. 14 with a discussion on **Forecasting Economic Variables Using the Delphi Technique**.

Delphi studies are used to develop a consensus view on future economic trends for key economic variables. You will be updated on the progress of a Society of Actuaries research project on conducting a delphi on economic variables. Then, attendees will actually participate in a delphi study on economic variables. This will allow you to gain an understanding of how to incorporate expert qualitative judgments about plausible global developments into forecasting economic variables.

On Tuesday morning, Nov. 15, we begin with a not-to-be-missed hot breakfast (beginning at 7 a.m.). We are thrilled to present a guest speaker, Emanuel Derman, at this breakfast. **Emanuel Derman** is a professor at Columbia University and director of their program in financial engineering.

In 1985, Dr. Derman was one of the co-developers of the Black-Derman-Toy interest-rate model. He also pioneered the study of local volatility models and the volatility smile.

Dr. Derman will speak to us on the areas of investment risk management and model use.

At 10:30 a.m. on Nov. 15, we will hold a session of **Variable Annuity Derivative Based Hedging: A Practical Application**. In the session, case study examples will be presented to demonstrate practical implications of these programs.

Focus is placed on dynamic versus static hedge programs as well as understanding the difference between economic, accounting and capital effects of variable annuity derivative-based hedging programs.

Later that same day (at 2:30 p.m.), we have two concurrent sessions. The first is entitled **Multicurrency Asset Portfolios**. The question we will attempt to answer is "With U.S. bonds yielding near all time lows and significantly less than non-U.S.

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denominated bonds, is there an opportunity for insurance companies to diversify their asset holdings into foreign currency denominated bonds?

Here, we will examine what an acceptable foreign currency risk profile should be relative to a liability portfolio, management of a multicurrency asset portfolio and currency overlay strategies.

At the same time on Tuesday (I know we will all have difficulty choosing which session to attend), we will also hold a session entitled **Life Insurance Securitization**.

With new deals closing almost every month, life insurance securitization has moved from a theoretical exercise to an effective approach to address capital needs. Here, our speakers will discuss the basics of life insurance securitization, review the various deals that have taken place and provide an outlook going forward.

We will return on Nov. 16 for our final day of sessions. At 8:30 a.m., we begin with **Economic Capital: Investment Implications**. As you are most likely aware, economic capital is an embedded part of the banking risk management and regulatory framework. The insurance industry has relied on rating agency and regulatory formulas that have been criticized as overcapitalizing and not appropriately differentiating risk drivers in the capital formulation. The emergence of C-3 Phase I and C-3 Phase II have introduced an economic approach to capital in the insurance industry.

Determining economic capital for interest rate, equity and even underwriting risk is a natural extension of much of the work actuaries do. This session explores different techniques for incorporating market and credit risk into an insurance company's economic capital framework.

Our final session on Nov. 16 at 10:30 a.m. is on **Performance Attribution Techniques**.

This session introduces you to the concepts and practices of investment performance evaluation and includes a discussion to identify and construct appropriate investment benchmarks and how to perform an attribution analysis, especially in an asset liability matching context. These concepts are framed relative to the evaluation of an investment manager's performance.

We hope to see all of you in NYC!!! Some of these sessions are also still looking for dynamic speakers. To register for the meeting, go to *www.SOAannualmeeting.org*.