The Intertek Group

CAN MODELING HELP DEAL WITH THE PENSION FUNDING CRISIS?

20 DECEMBER 2004

Frank J. Fabozzi, Yale University School of Management
Sergio Focardi, Partner, The Intertek Group
Caroline Jonas, Partner, The Intertek Group

This report is based on conversations with over forty persons from pension funds, the regulators, consultants and academics. The authors wish to thank all those who contributed, sharing with us their experience and their views.

Frank J. Fabozzi,
Email: fabozzi321@aol.com

Sergio M. Focardi
Email: interteksf@aol.com

Caroline L. Jonas
Email: intertekcj@aol.com

TABLE OF CONTENTS

ABOUT THE AUTHORS

THE INTERTEK GROUP

The Intertek Group is a Paris-based consultancy specialized in advanced computational methods in finance and industry. It undertakes research, trains and consults on the use of advanced modeling techniques and computational methods in the financial services sector. Partners of The Intertek Group have authored several books on financial modeling and risk management, including the recent *Mathematics of Financial Modeling & Investment Management* co-authored by Prof Fabozzi and Intertek partner Sergio Focardi (Wiley, 2004).

FRANK J. FABOZZI

Frank J. Fabozzi is the Frederick Frank Adjunct Professor of Finance in the School of Management at Yale University. He is a Fellow of the International Center for Finance at Yale University, editor of the *Journal of Portfolio Management*, a member of Princeton University's Advisory Council for the Department of Operations Research and Financial Engineering, and a trustee of the BlackRock complex of closed-end funds and Guardian Life sponsored open-end mutual funds. Frank has authored several books in investment management and in 2002 was inducted into the Fixed Income Analysts Society Hall of Fame.

CAN MODELING HELP DEAL WITH THE PENSION FUNDING CRISIS?

As of year-end 2002, more than 90% of the private-sector defined-benefit pension plans in the United Kingdom and the United States were underfunded. In the period 1999-2002, funding levels also dropped significantly in the Netherlands and Switzerland, though on average the funding ratio remained above 100%.[1] Frequently cited reasons behind today's funding problems include prolonged contribution holidays due to rising equity markets followed by the sharp drop of stock markets in the year 2000. This combined with lower interest rates which raised the value of liabilities. Business problems faced in some industries such as automobile, airlines, and steel exacerbated the problem. Actuarial and accounting practices allowed the underfunding to go undetected. In many cases, bad modeling (or absence of modeling) also helps to explain the pension funding crisis.

Risk has moved up in importance. Risk is two-fold. First, there is the risk that plan members might see their retirement benefits reduced. Second, there is the risk that sponsoring firms will have to make contributions that may jeopardize their ability to compete; indeed some firms' pension liabilities are bigger than their market capitalization. Given current levels of underfunding, contributions necessary to bring many funds back to target coverage ratios are now suboptimal with respect to an optimal flow of contributions made in due time. The objective of this study is to answer the question: Can modeling help deal with the pension funding crisis? Models (i.e., computer-based programs) are widely used in the financial and insurance industries to forecast the evolution of asset prices, optimize the risk-return trade-offs available, and measure and monitor financial risks. Indeed these functions cannot be performed without a model-based approach.

To understand to what extent modeling is used in managing pension funds and how modeling might help, we conducted interviews with pension fund managers, regulators, consultants and academics, and reviewed the literature. Specifically, we interviewed individuals managing defined-benefit plans [2] in the Netherlands (7), Switzerland (5), the United Kingdom (6), and the United States (10). The individuals interviewed are responsible for managing EUR 334 billion ($436bn) in assets. The average assets under management by participating funds is the following: for the Netherlands, EUR 15 billion ($20.7bn); for Switzerland, EUR 7.3 billion ($9.8bn); for the United Kingdom, EUR 11 billion ($14.6bn); and for the United States, EUR 12.3 billion ($16.5bn). Interviewees included some very large funds in each country as well as a number of funds of a more representative size; the latter represented half of the funds interviewed in each country. Funds with assets under EUR 1.5 billion ($2bn) were not included in this study: they typically depend on external consultants and have little in-house knowledge on modeling issues.

1) The problem of underfunding is not limited to private-sector plans; public plans also have funding problems, often more acute, however, questions of accounting practices and guarantees are different. For the most part, the modeling issues discussed in this study are the same.
2) In the Netherlands and in Switzerland pension funds are separate legal entities. This is not the case in the USA and the UK.

HIGHLIGHTS

The highlights of this study are:

- There is a growing focus on risk - risk to plan members in case of insolvency, risk to plan sponsors relative to the need to make large contributions. That the risk inherent in pension funds is similar to insurance risk is being recognized by the regulators in Europe.
- An additional risk to sponsoring firms (especially in the U.K. and the Netherlands) is the increased volatility in their annual reports that will come with the market valuation of pension plan assets and liabilities.
- With a growing awareness of liability risk, the focus is shifting from asset returns to an integrated view of assets and liabilities. This may, but does not necessarily, include adoption of liability benchmarking.
- The need to correctly project liabilities and to understand correlations between assets and liabilities is growing: the ability to effectively hedge risk depends on it.
- The risk management technique most widely used is scenario analysis. Based on theory and statistical analysis, models generate scenarios that capture the key relationships between assets and liabilities and between economic variables in general. The advantage of scenario analysis is that it allows what-if reasoning. Multi-stage stochastic optimization is being used by some participants.
- The question of just what asset classes a pension fund should hold is basically a question of risk. A bonds-only strategy had no takers among the funds interviewed. However, only two sources mentioned having invested more than 10% of their assets in alpha-boosting strategies such as hedge funds or portable alpha. Caution is the watchword.
- In a low-returns environment, the expectation is that full-fledged ALM will become increasingly important as wringing performance out of the markets to keep pace with liabilities growth will be difficult.

1. THE CURRENT PENSION FUNDING CRISIS : HOW WE GOT THERE

Underfunding of private-sector pension plans is estimated to be EU 337 billion ($450bn) in the United States alone.

The underfunding of private-sector pension plans is estimated to be EU 337 billion ($450bn) in the United States, EUR 87 billion ($116bn) in the United Kingdom (non financial firms only), and EUR 3 billion ($4bn) in the Netherlands. By some estimates, the underfunding among S&P 500 companies alone is $243 billion; this represents 40% of the estimated profits for S&P 500 firms for the year 2004[3].

Estimates on funding ratios depend on how liabilities are measured, e.g., on a current or termination basis.

The examples of Bethlehem Steel and US Airways in the United States are well known. Both companies arrived at severe underfunding while respecting regulations. Bethlehem Steel had reported that it was 84% funded on a current liability basis; however it was funded only 45% on a termination basis. The total underfunding was $4.3 billion at termination. US Airways had reported that its pilots' plan was 94% funded on a current liability basis; however, it was funded only 35% on a termination basis. The total underfunding was $2.2 billion at termination.[4]

High discount rates used to actualize liabilities minimized the need to make contributions.

Actuarial practices which make use of high discount rates to actualize pension liabilities played a role in the current underfunding of pension plans. So did legislation that allowed the use of two rates, one for financial reporting purposes and another for funding purposes. In the United States, and with some restrictions in the United Kingdom, the assumed long-term rate of return on assets (ROA) – typically equities and in recent years hedge funds – was allowed to determine minimum funding requirements. The difference between the two rates (the discount rate and the ROA) is somewhere between 2%-3%. The effect of rates used to discount liabilities is summarized by the following rule of thumb: a 0.5% increase in discount rates causes a 7.5% decrease in liabilities if the duration of the liabilities is approximately fifteen years.

Overoptimistic ROA assumptions artificially offset pension costs.

Parallel to the use of high rates to discount liabilities, overoptimistic assumptions were made on the ROA assumptions used to make actuarial projections of asset valuations. High ROA assumptions can be used to offset pension costs. An average annual return on assets in the range of 8%-9% has been typical in the United Kingdom and the United States[5]. Financial reporting rules also allowed sponsoring firms to "smooth" eventual market losses or gains experienced by their pension funds; in the case of the U.S., these gains or losses can be smoothed over a fifteen-year period or the life of the fund. As a result, the market value of assets held in a plan can be significantly different from their book value.

When markets fell in 2000, S&P 500

Economic causes also played a role in the underfunding. When the markets suffered a sharp correction in March 2000, pension funds saw

3) Richard Berner and Trevor Harris, EBRI/ERF Policy Forum 55, Morgan Stanley, 6 May 2004.
4) Testimony of Steven Kandarian, Executive Director, Pension Benefit Guaranty Corporation, US Senate, 14 October 2003.
5) "S&P 500 2003 Pension Status Report: Historical Pension Data", Standard & Poor's.

the value of their assets fall. Pension funds had significantly increased their holdings in equities throughout the bull market of 1987-2000. By 1992, the percent of pension holdings invested in equities was 75% in the United Kingdom, 47% in the United States, 18% in the Netherlands and 13% in Switzerland. In all countries except the United Kingdom, holdings in equities continued to grow as a percent of total assets. In 2001, midway through the bear market (March 2000 – October 2002) which saw popular indexes such as the S&P 500 lose about 50% of their value, U.K. pension funds had 64% of their total assets in equities; the figure for U.S. funds was 60%, for Dutch funds 50%, and for Swiss funds 39%. It was estimated that among the S&P 500 companies alone, $200 billion in pension fund assets were wiped out.[6]

companies lost an estimated $200bn in pension fund assets.

At the same time that stock markets were wiping billions off corporate pension plan assets, interest rates were falling sharply, increasing the present value of liabilities. Because pension portfolios were skewed towards equities, this increase in the value of liabilities was only partially offset by the parallel increase in the value of the bond portfolio. An analysis by Ryan and Fabozzi[7] illustrates the point. If the projected undiscounted liability stream is known, one can compute a *liability return* as the percent change in value of liabilities consequent to changes in interest rates. The authors computed the portfolio return and the liability return for a typical portfolio, using average asset allocation data and a Liability Index developed by Ryan Labs. The total return, obtained subtracting liabilities return from portfolio returns, was strongly negative in the years 2000, 2001, and 2002.

Simultaneously, a fall in interest rates increased the present value of liabilities as well as of fixed income portfolios. Because most portfolios were skewed towards equities, the offset was not complete.

A third factor in the underfunding was weakness in pension funding rules. These rules typically cover the admitted rates used to discount liabilities and assumptions on future returns discussed above; they might also stipulate the need to perform full-blown ALM studies and measure and monitor risk. Assumptions are an integral part of the modeling process, so wrong or overoptimistic assumptions are part of the modeling problem: there is no such thing as good modeling with bad assumptions.

Weak pension funding rules admitted assumptions on discount rates and ROA that resulted in an underestimation of funding requirements.

Pension funding rules also set funding targets and define the terms used. In testimony before the US Senate in 2003, then Executive Director of the Pension Benefit Guaranty Corporation (PBGC) Steven Kandarian cited the low funding target (90% of "current liabilities") as a problem. He commented, "The definition of current liability ... has no obvious relationship to the amount of money needed to pay all benefit liabilities if the plan terminates." The examples of Bethlehem Steel and US Airways cited above illustrate the problem. In the United Kingdom, the actual minimum funding requirement is by some

6) David Zion and Bill Carcache, "The Magic of Pension Accounting, Part II", Credit Suisse First Boston, 15 October 2003.
7) Ron Ryan and Frank Fabozzi, "Rethinking Pension Liabilities and Asset Allocation", *Journal of Portfolio Management*, Summer 2002, and Ryan and Fabozzi, "The Pension Crisis Revealed", *Journal of Investing*, Fall 2003.

estimates in the range of 50% to 70% of accrued liabilities.

Rules governing pension funds largely determine both the extent of modeling and the quality of the modeling effort. The case for modeling is simple: it allows an improved decision-making process and, eventually, optimization of the contribution schedule and management of assets. After talking to pension fund managers, regulators, consultants, and academics, it is the conclusion of this report that it is in the interests of all parties concerned to correctly model a pension fund's cash flow. Let's see why.

Rules governing pension funds largely determine both the extent of modeling and the quality of the modeling effort.

2. MANAGING THE RISKS

Pension fund management is a problem of risk management. Just how much risk each of the two parties (i.e., the sponsoring firm and the plan members) bear depends on the regulatory environment and the way the funds are managed. The risk inherent to *plan members* is handled differently in the four countries included in this study.

The regulatory framework determines how the risks are shared.

In the United States, the decision regarding the extent to which a firm funds its pension plan is considered an economic decision, but private-sector defined benefit pension plans must participate in the Pension Benefit Guaranty Corporation (PBGC) which provides a partial insurance of pensions. The PBGC charges a higher premium to funds reporting a funding level of under 90% of "current" liabilities.

In the U.S., the extent to which a firm funds its pension plan is considered an economic decision; the PBGC offers a partial guarantee.

In the UK, the Minimum Funding Requirement (MFR) is being replaced by a scheme-specific funding requirement to be set by sponsor and trustees. This will be based on a statutory funding objective to meet pension commitments when due to be paid, but including no regulatory minimum funding level. Contemporaneously, a Pension Protection Fund (PPF) on the model of the PBGC in the U.S. is scheduled to come into effect.

In the U.K., the MFR is being replaced by a fund-specific funding requirement, with no regulatory minimum funding level.

In Switzerland, where the minimum funding level is 100% on a termination basis, the accent is on conservative management (investment in equities, for example, is limited to 30% of total assets for funds with less than 110% coverage ratio). Funds with a shortfall are expected to make up the shortfall, but a Guarantee Fund was recently created to ensure (partial) payment of benefits in case of insolvency.

In Switzerland, there is a 100% minimum funding level and limits on investment in risky asset classes.

In the Netherlands, where the minimum funding level is 105% on a termination basis, new regulations deal with the risk to plan members by imposing additional risk-based solvency buffers, restrictions on assumptions, and standard criteria for the annual measurement of shortfall risk at one- and fifteen-year time horizons. There is no government-sponsored guarantee fund. The Dutch initiative is interesting in that it takes a model-based approach to managing the risks inherent in defined-benefit pension plans. Such an approach has

In the Netherlands, the minimum funding level is 105% plus additional buffers for investment risks; a model-based approach to measuring shortfall

already been adopted by bank regulators for market and credit risks. Responsibility for regulating pension funds has now come under the bank regulator, i.e., the Dutch national bank or DNB. (See the Appendix for a detailed summary of the above.)

risk is being implemented.

From the point of view of the *sponsor*, pension fund management is a problem in asset/liability management (ALM) with long-term risks. While objectives and solutions differ under different regulatory environments and from fund to fund, there is no way of escaping the need to manage contributions and asset allocation based on a projected stream of liabilities and a projected stream of returns under various constraints. Nested in ALM is the question of managing assets, i.e., asset management.

From the point of view of the sponsor, pension fund management is a problem in ALM with long-term risks.

ALM presents a risk-return optimization problem. There are two reasons for this:

1. The management of any sponsored pension fund impacts the global risk-return optimization process of the sponsoring firm;
2. There is a residual risk of reduced benefits for plan members in any privately funded pension plan.

ALM presents a risk-return optimization problem embodied in the trade-off between contributions, asset allocation and risk.

Risk-return optimization is embodied in the trade-off between contributions, asset allocation, and risk. Reducing the level of contributions (or holding them down to bearable levels) is a management issue common to all private-sector defined-benefit plans. In simple terms, other things being equal, the lower the pension contribution the higher the corporate earnings. As one source put it, "We use ALM to reduce the corporate cash contributions to the pension plan."

The need to hold contributions low is exacerbated by competition from firms whose pension liabilities are significantly lower or non-existent. An oft cited example comes from the automotive sector where it has been calculated that the cost of pensions plus medical benefits represent $631 of the cost of each Chrysler vehicle, $734 for each Ford vehicle, and $1,360 for each GM vehicle. This compares to a cost per vehicle of $107 for Honda and $180 for Toyota.[8]

The need to hold contributions low is exacerbated by competition from firms whose pension liabilities are significantly lower or non-existent.

Reducing contributions, however, might not be always optimal. For example, due to taxation rules in some countries, it might be advantageous for a sponsoring firm to borrow to make contributions

An additional risk comes from *volatility* and is related to the regulatory framework. There are two aspects. First, the new International Financial Reporting Standards (IFRS) which come into effect in January 2005, will require that pension assets and liabilities appear on the balance sheets (without smoothing) of the sponsoring firm. This is a novelty in the Netherlands and Switzerland, where the status of a fund as a separate legal entity has kept fund accounts off

An additional risk comes from new international financial reporting standards and market valuations of assets and liabilities

8) "Les Fonds de Retraite Après la Crise des Années 2000", *Conjuncture*, BNP Paribas, January 2004.

corporate annual reports. Second, market valuations of a fund's assets and liabilities will come into effect in the United Kingdom in 2005 (with the FRS17) and in the Netherlands in 2006. This will introduce greater volatility in the funding ratio and be reflected on annual corporate results. Volatility has thus moved up as a major concern to firms offering defined-benefit pension plans. Volatility is, however, less of an issue in the United States, where a high degree of discretionary liberty in determining the discount rate for valuing liabilities and ROA assumptions coupled with smoothing techniques allow a plan to reduce volatility in balance sheets.

which will increase volatility on a sponsor's balance sheet.

3. MANAGING AGAINST WHAT BENCHMARK?

The focus in managing pension funds has traditionally been – and in many cases still is – on investment management, i.e., managing against a returns benchmark for an asset class. Managing for returns might not be optimal from the point of view of the sponsoring firm, as common factors drive assets and liabilities. In the presence of common factors, the quest for maximum returns might result in liability volatility maximization with global adverse effects. As a result, one might find that high returns are correlated with even higher liabilities, producing a total negative return.

The focus in managing pension funds has traditionally been on asset management; this is still largely the case in the U.S. and the U.K.

A different approach is to manage against the liabilities of the fund, i.e., managing against a liability benchmark. Liability benchmarking means that a liability index (i.e., an aggregate view of a fund's liabilities) is created, and assets and liabilities are managed taking into account the correlations between the two. The two strategies might be substantially different. We asked participants if they had adopted or were considering adopting liability benchmarking.

70% of the funds mentioned that they did not use, nor were they considering using, a liability benchmarking approach. Only 11% mentioned having adopted a liability benchmarking approach; another 19% mentioned that they were considering adopting such an approach or other ways to take liabilities into consideration in their benchmark. A source at a Dutch fund which has switched to liability benchmarking remarked, "The new regulatory framework requires discounting liabilities with a market interest rate: risk now comes from the liability side. The benchmark is now our liability, which has become our biggest risk."

In the Netherlands, a new regulatory framework introduces market valuation of liabilities and mandates the integration of assets and liabilities.

Among the funds that remarked that they are considering a liability benchmarking approach or other ways to incorporate liabilities in their benchmark, a source at a large Dutch fund remarked, "It is good to incorporate liabilities in the benchmark. Yet in our opinion, liabilities should be only one element in the benchmark. We start by generating a strategic portfolio that takes into account liabilities and then generate the appropriate benchmark. But with a large equity weighting, it makes no sense to compare it with a liability-driven benchmark." Another source commented, "Liability benchmarking should be the starting point, the anchor point, but the hedge is not perfect. We start

Some firms not adopting liability benchmarking are exploring ways to incorporate liabilities into their benchmarks.

by evaluating how they feel about the markets, what is overpriced, underpriced...An asset allocation with 70% in equities would embed a huge quantity of equity risk that we don't have liabilities on. This risk must measure appropriately and this is why liability benchmarking is a good starting point."

In the U.S. and the U.K., funds with strong cash flows typically reported that they manage for long-term returns.

In the U.S. and the U.K., funds with strong cash flows or high funding ratios typically reported that they manage for long-term investment returns. Most sources from these countries consider that a cash-rich company with an open plan has little reason to adopt a liability benchmarking approach. One source commented, "Because we consider our plan as on-going, we do not focus on the liabilities. We are aware of liabilities – but not much more – when managing assets." Another source said, "We are not using, nor are we considering using a liability benchmarking approach. We have no objective to improve the matching of assets and liabilities." A third source said, "We are not using liability benchmarking: we believe that we can exploit assets to our advantage."

Peer group benchmarking has obfuscated the biggest risk: the asset/liability mismatch.

In practice, other considerations play a role. Peer group benchmarking, i.e., evaluating a fund's performance against the average performance of a group of similar funds, is widely used. Peer group benchmarks entail a considerable level of herding in the management of funds and might produce fundamental distortions with respect to the real problem of a pension fund, i.e., paying pensions.

An exposure (albeit limited) to long duration bonds would be desirable.

In his editorial comments to the November/December 2004 issue of the *Financial Analysts Journal*, Robert Arnott comments on the distortions due to peer benchmarks which obfuscate the biggest risk: asset/liability mismatch. Arnott observes that fixed obligations behave as a laddered bond portfolio.[9] The largest portion of liability sensitivity to interest rates is due to liabilities with long time horizons. Though their net present value might be comparatively small, their duration is long; they are thus highly sensitive to interest rates. This consideration, observes Arnott, strongly suggests at least a limited exposure to long duration bonds. Most pension funds hold bonds with relatively short duration: the reason is the pressure due to peer group benchmarks. Several sources commented on the need to review the duration of their bonds. One source in the Netherlands said, "We might want to tailor a bit more to our liabilities with longer-term bonds."

An exposure (albeit limited) to long duration bonds would be desirable.

In his editorial comments to the November/December 2004 issue of the *Financial Analysts Journal*, Robert Arnott comments on the distortions brought by peer benchmarks which obfuscate the biggest risk, asset/liability mismatch. Arnott observes that fixed obligations behave as a laddered bond portfolio.[10] The largest portion of liability

9) If long term obligations are inflation indexed they behave as a laddered TIPS portfolios. TIPS, or Treasury Inflation-Indexed Securities, are US Government bonds.

10) If long term obligations are inflation indexed they behave as a laddered TIPS portfolios. TIPS, or Treasury Inflation-Indexed Securities, are US Government bonds.

sensitivity to interest rates is due to liabilities with long time horizons. Though their net present value might be comparatively small, their duration is long; they are thus highly sensitive to interest rates. This consideration, observes Arnott, strongly suggests at least a limited exposure to long duration bonds. Most pension funds hold bonds with relatively short duration: the reason is the pressure due to peer group benchmarks. However, several sources commented on the need to review the duration of their bonds. One source in the Netherlands said, "We might want to tailor a bit more to our liabilities with longer-term bonds."

4. PRICING PENSIONS: AN INSURANCE PROBLEM?

Conceptually, the risk-return optimization process of a pension fund which leads to an optimal level of contribution is similar to the process of determining an insurance premium. It was the Swede Philip Lundberg who, defending his doctorate thesis in Upsala back in 1902, introduced the mathematics of risk theory that are still the basis of insurance pricing. An insurance firm receives premiums from its policy holders and is subject to an uncertain stream of claims. If the cumulated value of premiums is insufficient to cover the cumulated value of claims, the insurance firm faces insolvency. Premiums are priced to ensure that the probability of ruin (i.e., insolvency) remains within acceptable boundaries.

Conceptually, the risk-return optimization process of a pension fund which leads to an optimal level of contribution is similar to the process of determining an insurance premium.

In Switzerland and the Netherlands, insurance firms play an important role in the pension fund industry. In Switzerland, for example, some one fourth of the total 580 billion Swiss francs of pension fund assets/liabilities are managed by insurance firms; the legislation governing pension funds is, however, different from that governing insurance firms. In the Netherlands, the new regulatory framework for pensions which comes into effect in 2006, integrates both pension funds and insurance companies under the same framework.

In Switzerland and the Netherlands, insurance firms play an important role in the pension fund industry.

Though both pension funds and insurance firms have the problem of determining a stream of payments which can cover stochastic liabilities within given confidence bands, the modeling approaches adopted are not strictly the same. In recent years, a number of researchers, including Paul Embrechts, have argued in favor of a unified treatment of finance and insurance. A project (Solvency II) under discussion in the European Union is working on a proposal for a common framework for the two.

In recent years, a number of researchers have argued in favor of a unified treatment of finance and insurance.

5. MANAGING ASSETS AND LIABILITIES

The basis for pension modeling consists of 1) actuarial mathematics to model liabilities and 2) finance theory and econometrics to model asset returns. An ALM exercise integrates the liabilities and assets projected into the future. It should provide answers to three questions:

The basis for pension modeling consists of 1) actuarial mathematics to model liabilities and 2) finance theory and econometrics to

1. What contribution should be made to the fund this period (generally one or more years)?

2. What is the projected contribution in the future?
3. How should assets be allocated between the different assets classes?

model asset returns.

A source at a large Dutch fund remarked, "A multi-stage ALM study should be at the core of any pension fund plan design. It is absolutely key and explains some 90% of the risk and returns." Full-fledged ALM studies are based on computer models that project future liabilities and returns, integrate their "paths", explore alternative scenarios, and optimize the risk-return trade-offs.

One source said, "A multi-stage ALM study should be at the core of any pension fund plan design. It is absolutely key."

We asked our sources how frequently they (or more typically their consultants) performed ALM studies. Four sources mentioned doing yearly studies (3 in the Netherlands and 1 in the U.S.); the remainder do an ALM study every three to five years. Of the latter, several mentioned that the study was done in an informal or qualitative way. A proponent of doing ALM studies yearly said, "If one uses more frequent ALM studies, one builds up an intuition for modeling. If model results change year to year, it is clear that you have to modify the plan. A more careful analysis of assets [back in the year 2000] could have largely prevented or foreseen a drop in the surplus."

Four sources mentioned doing yearly ALM studies; the remainder do one study every three to five years. Of the latter, several mentioned that the study was done in an informal or qualitative way.

Among those doing full-fledged ALM, a source at a large Dutch fund commented, "ALM is a key tool to deliver quantitative-based information to our board of trustees. It allows for investigating the impact of various investment, contribution, indexation, and financing policies; as such, it supports decision-making at strategic levels." A source in the U.S. added, "Modeling itself is not where the value lies; value comes from the dialogue with fiduciaries which modeling fosters. How do you find out what the fiduciaries' risk tolerance is? Modeling allows you to explore this; it fosters a good process. You need a process that can show what might happen on the downside. Modeling forces a dialogue that might be easily understood."

A source at a large Dutch fund commented, "ALM is a key tool to deliver quantitative-based information to our board of trustees."

However, ALM technology can be a challenge even to sophisticated users. One source commented, "At times it can be complex to understand what is going on as there are interactions between many policies, many parameters. There might be a lack of clarity about the way stochastic scenarios are being generated.... It takes quite a while to get a reasonably good grip on all the tools."

ALM technology can be a challenge even to sophisticated users.

Most sources that rely on model-based ALM commented that the software is pretty good on integrating assets and liabilities. However, there are a number of issues. First, there is the question of how explicit the modeling is. One source using a Wilkie-derived model commented, "Some of the interactions between the liability and asset models are not explicit. It would be better to have more explicit liability risk models before laying out the assets, plus a more explicit view on assets to view assumptions and separate out the assets and liabilities. To what extent is experience included? For example, equity

Most sources that rely on model-based ALM give today's software good marks on integrating assets and liabilities.

volatility is high when equity performance is bad, and correlations are high when equities are doing badly, so you lose the value of diversification."

Another important aspect of ALM, the integration of the pension plan with the sponsoring firm, has important consequences in many areas of planning, in particular borrowing.

Another important aspect of ALM, the integration of the pension plan with the sponsoring firm, has important consequences in many areas of planning. In particular, it affects the opportunity of borrowing. The advantages consequent to the adoption of an integrated sponsor-plan financial planning is illustrated in a paper by J. Mulvey, K. Simsek, Z. Zhang, F. Fabozzi and B. Pauling, *Assisting Underfunded U.S. Pension Plans*, December 2003. In this paper, an integrated stochastic planning model for the integrated management of pension plans is proposed. The authors use the CAP:Link System for scenario generation and multistage stochastic programming for the actual planning process. The goal is to maximize expected wealth at the end of the planning horizon with constraints to protect the pension, pay beneficiaries over the planning period, and minimize the risk that the plan will collapse. Risk measures involve the probability of making a large contribution, the likelihood of a bankruptcy over the 9-year planning period, and related worst case events. The paper points out that borrowing is optimal in some given circumstances.

Confronted with the need to hedge inflation, effective instruments such as inflation-linked bonds are considered to be an expensive solution.

One important question that emerged from the study is the ability to hedge inflation. Pension plans where pensions are indexed to inflation run the risk of underfunding due to inflationary pressure which pushes up pensions. Sources expressed concern related to the integration of inflation rates into asset and liability management: the integration of inflation constraints in both asset and liability management could result in growing use of inflation-indexed bonds. Equities are not considered to offer a natural hedging to inflation but pure inflation-indexed bonds are considered too expensive. Many consider that equities do not offer a natural hedging to inflation. A source at a major fund in The Netherlands summed it up as follows: "Liabilities grow with a rate of inflation different than that of products available in the market. If you want to hedge inflation you can buy products such as inflation linked bonds but the hedge is not perfect."

6. MODELING LIABILITIES

Actuarial models used to calculate present and future liabilities are widely considered to be "standard" and, sources say, they are not part of the selection process of an actuary.

Liabilities are calculated by first making actuarial projections of a plan's annual payments and then discounting these back to the present. Actuarial models used to calculate present and future liabilities are widely considered to be "standard" and, sources say, they are not part of the selection process of an actuary. The fact is that the actuaries are not keen to share their models. Back in 1994, Macbeth and colleagues[11] wrote, "[M]ost sponsors have a sketchy understanding of actuarial techniques, and actuaries do not go out of their way to make their craft understandable to sponsors". Not much has changed in most countries. "Actuarial models are proprietary so we do not have access

11) J.M. Macbeth, D.C. Emanuel and C.E. Heatter, "An investment strategy for defined-benefit pension plans", *Financial Analysts Journal*, May/June 1994, 34-41

to them, only the inputs and the outputs," one source in the U.S. remarked. However, familiarity with (and indeed hands on experience with) actuarial models is growing. 23 sources mentioned using external consultants for the task; however, 5 mentioned that they run their own liability studies in-house, using commercially available or in-house software.

Challenges in modeling future liabilities include, in addition to discount rates and inflation rate, changing demographics and high turnover in the workforce, but most sources were reasonably satisfied with present modeling. One source commented, "The models work reasonably well for us: because our plans are mature and we have historical data, we are able to control noise factors such as changes in compensation." Another source observed, "80% of the problem with volatility in liability modeling comes from the volatility of interest rates. Plans have a duration of 10-15 years and if one uses market interest rates, a 1% move results in a 10% modification of liabilities, a 2% move a 20% change, and so forth."

Challenges in modeling future liabilities include, in addition to discount rates and inflation rate, changing demographics and turnover, but most sources were reasonably satisfied with present modeling.

One big question regarding inputs in liability modeling is the rate used to discount liabilities, mentioned above. Liabilities are calculated by making actuarial projections for a plan's annual payments and discounting these back to the present. Admitted rates are subject to regulation and vary from country to country.

One big question regarding inputs in liability modeling is the rate used to discount liabilities.

In the U.S., one rate might be used for accounting purposes (i.e., a AA corporate bond rate or c. 6.25%) and another typically higher rate for funding purposes. The latter is based on the expected long-term rate of return on equities. Over the last ten years, this figure has been in the range of 8%-9%.[12] One U.S.A. source said, "For funding decisions, we use an assumed earnings rate which is obviously higher [than the AA corporate bond rate] given our asset mix which is high in equities."

In the U.S., one rate might be used for accounting purposes and another typically higher rate for funding purposes.

The use of AA corporate bond rates is controversial.[13] As the rate of a AA bond ultimately depends on the spread, there is a large latitude in the choice of possible rates. Paradoxically, corporations with underfunded plans could see their underfunding reduced significantly if AA corporate issuers become riskier!

The use of AA corporate bond rates is controversial.

The United Kingdom also allows the use of two rates, one for financial reporting purposes, the other for funding purposes. For the former, the rate of 6.5% plus a full set of economic assumptions is typical. One large fund in the U.K: commented, "Given that we have no net liabilities in sight, the issue [of the discount rate] is somewhat redundant. Our actuary applies a rate; the investment committee does not focus on this." New rules which come into effect in 2005 will

The U.K. also allows the use of two rates, one for financial reporting purposes, the other for funding purposes.

12) "S&P 500 2003 Pension Status Report: Historical Pension Data", Standard & Poor's.
13) For problems with the use of corporate bond index required by the Pension Funding Equity Act of 2004, see Ron Ryan, "Critique of the New Pension Bill", Ryan ALM, 2004.

require using the market yield on high-grade corporate bonds or equivalent for financial reporting purposes. For the purpose of determining contributions under the Minimum Funding Requirement (MFR), the expected long-term rate of return on equities is admitted, albeit with some restrictions.

In Switzerland a static rate of 4% is used.

In Switzerland a static rate of 4% is used. One source in Switzerland remarked, "This is too high today, but actuaries are still using it," adding, "We are not always in a position to question the actuary's assumptions."

In the Netherlands, a static 4% will be replaced by market valuations in 2006.

In the Netherlands, the regulatory maximum of a static 4% has also been the rule, but a lower rate is sometimes used. New rules which come into effect in 2006 will require a market valuation; half the Dutch funds participating in this study mentioned having done some work internally on this.

Market valuations entail the modeling of an entire term structure.

The problem with modeling interest rates is that the evolution of the entire term structure of interest rates should be modeled as there is a different rate for each future maturity. Simplifications are called for. According to one source at a large financial institution, "The rate used for discounting liabilities should be a term structure and allow for some small credit spread. One needs to model for the future (i.e., project rates in the future). We model in a simplistic way, with regressive models, as we must be able to explain results to management."

Modeling the term structure is not an easy task.

Referring to the shift to market valuations of liabilities, a source at a large Dutch fund said, "Most likely, we will use a swap-based curve for this. We are already extensively modeling this in order to investigate the possible impact on our investment policy. For the moment we do not model the shape of the curve, only the initial part of the curve. If and when the regulators impose a full-fledged term structure modeling, we will use it. Another source said, "New regulations call for use of fair value. We use the yield curve for money markets - either the government recommendation, a swap curve or something in between. It is one of the main risks: most pension funds have a long duration gap, i.e., 15 years on the liability side against a 5-year duration for half of the investments."

The market valuation of liabilities is easy if appropriate instruments are available. A source at a large Dutch fund said, "We estimate liabilities on a fair value basis: it gives a better estimate of the real value of liabilities. If you have a cash flow you know you have to pay, say 1,000 Euros in 20 years in the future, the only reasonable thing is to use a zero-coupon bond that will pay out 1,000 Euros in 20 years time." However, zero coupon bonds of the right maturity are not always available.

One source said, "The industry is fooling itself with the

Some funds take a simple but powerful macroeconomic view of the discount rate problem. One source at a large financial institution

commented, "The industry is fooling itself with the discount rate. Inflation rates and interest rates are the only macro elements of concern to forecast on the liability side. We should be using these rather than the discount rate to value today's liabilities." Some investment consultants agree. According to one, "In modeling long-term liabilities, the only thing you need is a long-term model of the factors that effect the liabilities, namely inflation and real interest rates."

discount rate. Inflation rates and interest rates are the only macro elements of concern to forecast on the liability side."

A consequence of the adoption of market valuation is the need to consider spreads. Most sources reported that they do not model spreads; for many this is too theoretical a question. However several sources said that they do look at spreads qualitatively. One source commented, "We look at spreads for a long period, when there is mean reversion. But rather than model spreads, we look at extremes versus the base case spread."

A consequence of the adoption of market valuation is the need to consider spreads.

As mentioned, the use of corporate bonds is controversial. By using appropriate spreads, in fact, one can eliminate a large fraction of eventual underfunding. To see this point, suppose corporations are underfunded by an average of X% and have a duration of Y. One can determine how much corporate AA spreads would have to increase in order to determine how to eliminate the underfunding. i.e., solve the crisis, by making corporations riskier!

One fund where spreads are being modeled commented, "We used to use Moody's spreads but found that there was too much volatility, so we took the Moody's data apart and looked at it. After doing so, we decided to use our own rates which we calculated by taking the riskfree rate and adding a spread. It is very important in the corporate space to understand where the costs are going – and what the arguments might be for calculating higher or lowers spreads."

Note that hedging liabilities cannot be done without valuing liabilities at market rates. The only reasonable way to fully hedge liability is using STRIPS in the USA and equivalent products, when available, in other countries. Any other strategy entails a risk and cannot be considered a true hedging strategy.

Hedging liabilities requires the use of market rates.

7. MODELING FUTURE RETURNS

We asked participants if they modeled future returns on assets (ROA). Results were mixed: it is very much a question of investment style and attitudes towards quantitative methods. In Switzerland, for example, judgment is often applied to historical return figures to arrive at a qualitative forecast of returns; "caution" is the watchword in investing assets. A source at a large Swiss fund said, "We take a very very conservative approach which is, I believe, typical of the biggest Swiss pension funds with the exception of banks which use a different knowledge. We think this saves us money as we don't jump around that much." When modeling is done, it tends to be done on a five-year time horizon, with yearly reviews of assumptions.

Many funds make a *qualitative* forecast of returns based on historical returns, eschewing modeling. This is typical of the conservative approach used in Switzerland, and of the U.K.

In the United Kingdom, there is a certain reticence to use models; even some very large funds that manage assets in-house do so without using quantitative methods. A similar reluctance to use modeling is true of the asset management community as well.[14] Only 2 in 6 funds mentioned using models to forecast returns; the modeling is being done by external consultants as part of an ALM exercise run every three or so years.

In the U.S., ROA modeling is typically done on a 5-year horizon, using a top-down or bottom-up approach.

In the United States, where the focus remains on asset management, 7 of the 10 participating funds mentioned doing asset return modeling *in-house*; the typical time horizon modeled is five years out. The use of modeling is not only a function of size (some very large funds are managed without modeling) but also of culture. Top-down and bottom-up approaches are used. A source at a very large fund said, "We use economic theory. Assets should grow in line with inflation and real growth. Real growth is in the range of 2% - 3.5% in the long range though it might be off a bit in the short range. Forecasting inflation is somewhat more difficult, but believe one can do reasonable forecasts. So we start from the risk-free rate and build up and tie this to economic growth." Another source commented, "When we did our ALM exercise to come up with returns, we used 1) historical data, 2) overlay with return expectations bottom-up, 3) overlay with the industry consensus, with what our in-house people thought and what our investment bankers thought."

Volatile markets and new asset classes call for looking at extremes.

Given today's volatile stock markets and new asset classes, some sources underlined the importance of looking at extremes. But, relative to alternative asset classes, one source observed, "There are not long time series on hedge funds and data on private equity are not satisfactory."

One U.S. fund that is not using modeling explained, "We use long-term historicals. Returns modeling is not important as we manage for the long term: we haven't promised our plan members to make excess returns, simply to make market returns. We identify a market proxy (index) and accept what the market brings; the markets cannot be timed. [Because of correlations between assets and liabilities,] every time you flip asset allocation, liabilities drive you to the same result."

Large Dutch funds typically model returns over multiple time horizons.

Returns modeling is the rule among large Dutch funds, where there is a tendency to model multiple time horizons. The new regulatory framework will reinforce this as it requires risk modeling on 1-year and 15-year time horizons. The new framework is interesting in that it requires the explicit indication of assumptions on investment returns (as well as short- and long-term interest rates, inflation, etc.). Continuity tests used to measure long-term risk and performed periodically will allow funds to track their ability to make forecasts.

---

14) See "Trends in Quantitative Asset Management in Europe", F. J. Fabozzi, S. M. Focardi, and C. L. Jonas, *Journal of Portfolio Management*, Special European Issue, Summer 2004.

8. GENERATING SCENARIOS

Managing assets when liabilities reach maturity fifteen years out poses the problem of evaluating the long-term risks involved in a plan's strategy. The technique most widely used to evaluate the impact of possible future movements is scenario generation: it was cited by 60% of the participants. In particular, it is used by all the Dutch funds and a great majority of the U.S. funds.

The technique most widely used to evaluate the impact of possible future movements is scenario generation.

Scenario generation is performed creating a set of scenarios, on demand or computer generated. Economic scenarios are the different possible "paths" that economic variables such inflation, interest rates or the markets might take; liability scenarios are the possible paths that liabilities might take. Typically, the two are *dependent*: for example, the distribution of final pay, which is often used as a determinant of pension benefits, is likely to depend on the economic environment, e.g., inflation, unemployment.

Scenario generation is performed creating a set of scenarios, on demand or computer generated.

Because it allows for what-if reasoning, scenario generation is considered an easy tool to facilitate discussions with trustees. A few sources mentioned that scenarios are generated on demand. One source at a large fund in the U.K. remarked, "As we approach the results of the ALM study, we are typically interested in a few what-if scenarios which we ask the consultant to run."

One problem with on-demand scenarios is that judgment has constrained the search area. One source commented, "What if the scenarios we imagine are not the scenarios that are realized?" Limiting scenario generation to several deterministic questions also limits the possibilities of optimization.

One problem with on-demand scenarios is that judgment has constrained the search area.

More typically anywhere from 500 to 10,000 scenarios are generated by the computer. The generation of upwards 500 scenarios presents a problem: which of the hundreds (or thousands) of scenarios is the most likely to be realized? One solution is to assign probabilities (i.e., likelihood) to the scenarios. This is done by commercial software such as the Ortec software in the Netherlands and the Tepper software which is run in-house by many large companies in the United States. A proponent of assigning probabilities commented, "One is better off with some estimate of probability because of the difficulty of solving the problem. Assigning probabilities helps identify central tendencies." However, some sources remarked that decision-makers have difficulty reasoning in terms of probability. The Ortec software widely used in the Netherlands can handle probability in an intuitive way. A large number of scenarios, say 10,000, are randomly generated, with the objective of understanding where best solutions *aggregate*.

More typically anywhere from 500 to 10,000 scenarios are generated by the computer. Various computational techniques are then used to identify central tendencies or aggregate best solutions.

9. OPTIMIZATION

In its most mature implementation, an ALM system is an optimization system in which probabilities are assigned to each scenario and

Just over 2/3^{rds} of the participating funds

objectives and constraints defined. Just over 2/3^{rds} of the participating funds said that they use optimization. Typically, optimization is run by the external consultant every three or so years, as part of the ALM exercise.

said that they use optimization.

An optimization objective might be, for example, to minimize contributions subject to a given maximum risk. One problem cited with the use of optimization was the existence of multiple objectives, e.g., minimize contributions, honor obligations. However, a proponent of optimization said, "Optimization is simply a way of looking at a large number of scenarios to select from; it is an organized search through undominated solutions." Multiple objectives can be handled in different ways. Objectives might be aggregated into a single objective under a number of constraints. Also there is some freedom in choosing objectives and constraints: one might, for example, try to find an optimal compromise between risk and return or, alternatively, might maximize returns under risk constraints.

One problem cited with the use of optimization was the existence of multiple objectives.

Roughly half of those using optimization mentioned that they perform full-fledged multi-stage stochastic optimization. In portfolio management, optimization is generally considered a "brittle" technology, sensitive to the input data and prone to error maximization. However, in the context of ALM, sources familiar with stochastic optimization disagree. A proponent of multi-stage stochastic optimization remarked, "Dynamic analysis of multistage stochastic optimization is more realistic than a static single-stage model. It is actually less sensitive to errors in long-term forecasts because of mean reversion. With longer time horizons, it is easier to predict central tendencies - though not tail events." The robustness of stochastic optimization in ALM might be explained by the input data (i.e., the scenarios) which are subject to many constraints. In fact, cointegration and mean reversion, which are typically embedded in scenarios, constrain data.

One fund that uses optimization said, "Optimization is fine as long as it is combined with Monte Carlo and stress testing to capture fat-tail events or correlations that are not stable."

One fund that uses optimization said, "Optimization is fine as long as it is combined with Monte Carlo and stress testing to capture fat-tail events or correlations that are not stable."

Still, a number of funds mentioned that they prefer simulation to optimization. According to one of these, "Stochastic optimization involves all sorts of complications. It requires patches everywhere to make it work. It is a complete black box to the investment committee. Simulation, on the other hand, is not so constrained in how you handle returns; it allows one to simulate dynamic investment strategies. It gives you the distributions, the confidence levels."

Many funds prefer simulation to optimization.

10. RISK MANAGEMENT AND RISK MEASURES

We asked participants to comment on their risk management processes. 40% of the participants do no risk modeling of their pension plans; 25% considered their risk modeling as moderate (typically done every three years during the ALM study) while 35%

40% of the participants do no risk modeling of their pension plans;

considered their risk modeling effort significant. A number of funds not modeling risk in ALM mentioned that they do model risk in asset management: this is typical of funds focusing on investment returns.

25% considered their risk modeling as moderate while 35% considered it significant.

In commenting on their ability to model risks, one source said, "Some risks, such as salary variances, basis assumptions and mortality, are not modeling well. A good holistic model would include these."

Scenario analysis was cited by all funds doing model-based risk management. The technique most widely used to generate scenarios is Monte Carlo. One source said, "We use Monte Carlo simulations, running anywhere between 5,000 to 10,000 simulations, without assigning probabilities. The objective is to open up possibilities for management to reason on, to be aware of fat tail risk, risky events."

The technique most widely used to generate scenarios is Monte Carlo.

While a number of sources mentioned that they eschewed the assignment of probabilities to scenarios ("management has a problem reasoning in probability"), others found assigning probabilities useful. According to one source, "We use Monte Carlo models to understand what the chances of something happening is. The software assigns probabilities so one can have an idea of what could happen and the confidence bands. This is important as it helps bring focus." Another source said, "If it is a question of estimating central tendencies, one is better off with some estimate of probability because of the difficulty of solving the problem."

Some funds eschew the assignment of probabilities to scenarios, others find assigning probabilities useful.

Other techniques are used by some big funds. A large industry-wide Dutch fund which characterized their use of risk modeling as significant remarked, "We use Monte Carlo simulations, deterministic regimes, and stress testing." The need to look at skewness and kurtosis was also mentioned. In fact, it is well known that stock returns exhibit fat tails (kurtosis) and are asymmetric (skewness).

Skewness and kurtosis are gaining more attention.

There is, however, no consensus on the measures of risk. Familiar risk measures such as VaR (which the Dutch regulator has adopted for solvency tests in the Financial Review Framework which is to come into effect in 2006) and variance have a number of drawbacks. Measures of asymmetric risk (i.e., the risk of shortfall) and coherent risk measures[15] such as conditional VaR have also been suggested. Behind the technicalities of risk measurement there is the problem of understanding just what risk one wants to measure. One source at a large financial institution commented, "We are looking seriously at conditional VaR and working on overall risk, drilling down to break up the risk into different sources, e.g., inflation risk, credit and market risk."[16]

There is no consensus on risk measures. Behind the technicalities of risk measurement there is the problem of understanding just what risk one wants to measure.

15) Risk measures are said to be "coherent" if they respect a number of conditions including subadditivity. VaR is not subadditive, i.e., the VaR of aggregated plans can be bigger than the sum of individual VaRs, so it cannot be considered to be coherent.

16) "Prudence dans le domaine des placements en des temps difficiles", ASIP, 5 March 2003.

11. A DISCONNECT BETWEEN MODELING AND DECISION-MAKING?

A problem widely commented on is the failure to integrate the results of the ALM study in the decision-making process. One investment consultant remarked, "Often there is no real link between the model and the decision, that is to say, the decision is based on prior assumptions. Interestingly one observes similar asset allocations within individual countries despite substantial differences in the modeling approach of the different consulting firms and widespread differences across countries despite basic similarities in modeling approaches (i.e., same consulting firms). This may be explained by the fact that modeling is largely used to justify a decision that was taken for other reasons." A pension fund manager in the U.S. added, "ALM technology is ok, applying it is a whole other story.... The models are disconnected from practice; often they are only cosmetic. A lot of time and effort is spent fitting the data into accounting standards rather than adhering to the model." Dutch sources, however, generally considered that modeling results were well integrated into the decision-making process.

A problem widely commented on is the failure to integrate the results of the ALM study in the decision-making process. One source said, "The models are disconnected from practice; often they are only cosmetic."

Familiarity with models is very much related to the prevailing culture, the regulatory framework, and the investment management style. About one third of the participants in the study mentioned either doing no modeling or having no opinion on models used. One source commented, "Rightly or wrongly, we are in the hands of our investment consultants. We do not debate with them either the assumptions or the models."

Familiarity with models is related to the prevailing culture, regulatory framework, and investment management style.

Just under half of the funds, however, mentioned having hand-on experience with models. Familiarity with models is highest in the United States and the Netherlands. In most cases, it is a question of running in-house third-party models such as the popular Tepper software in the United States or Ortec software in the Netherlands. A source at a large Dutch fund said, "Given its pivotal role, I would recommend any pension fund to carry out its ALM study to a large degree in-house." A few sources also mentioned "tweaking" third-party models to their particular needs; two sources indicated that they design their models in-house.

Just under half of the funds mentioned having hands-on experience with models.

Familiarity with modeling is related, to some extent, to the size of the plan. Plan sizes are typically small in Switzerland and the United Kingdom, with literally thousands of single-employer plans under EUR 2 billion. Switzerland, for example, with a GDP two thirds that of the Netherlands, has some ten times as many private-sector pension plans. Small plans cannot typically afford to build up in-house quantitative and modeling teams. However, we talked to a number of very big plans that eschewed modeling altogether, focusing exclusively on investment returns.

Familiarity with modeling is related, to some extent, to the size of the plan.

The need to build up in-house expertise on modeling issues has been recognized in the Netherlands. In a draft code on pension fund governance, a working committee of the Dutch Association of

The need to build up in-house expertise on modeling issues has

Industry-wide Pension Funds (the VB) includes among best practices the requirement for appropriate *internal* risk management and control system tools to analyze, monitor and report on risk. But even smaller funds are building up their expertise. A source at a single-employer Dutch fund managing some EUR 2 billion in assets commented, "Our knowledge on modeling is growing."

been recognized in the Netherlands.

12. VALIDATION OF MODELS

One question that the use of proprietary ALM models raises is the question of model validation. Consultants' models are based on different assumptions and different modeling techniques (see the Appendix) but there is neither an open debate on the models nor an independent body to verify the models similar to what exists in the banking sector. Nevertheless, in the countries surveyed, we are talking about models being used to manage EUR 3,057 trillion ($4,077tn) in pension fund assets when ALM is estimated to be responsible for more than 90% of a fund's performance and risk. The new Financial Review Framework which will come into effect in the Netherlands in 2006 is an interesting step in the direction of validating models used for risk management similar to what has been implemented for market and credit risk in the banking sector.

The new Financial Review Framework which will come into effect in the Netherlands in 2006 is a step in the direction of validating models used for risk management similar to what has been implemented for risk in the banking sector.

13. BONDS ONLY?

There is an on-going debate as to just what is an appropriate asset class for funds to hold. We asked participants what they thought. None of the 28 sources subscribed to the idea that bonds are the only appropriate asset class for a defined-benefit pension plan. This evaluation was across plans, including plans whose holdings in equities as a percent of total assets under management went from a low of 10% to high of 80%. The consensus is that investing only in bonds would make pensions too expensive.

None of the 28 sources subscribed to the idea that bonds are the only appropriate asset class for a defined-benefit pension plan.

The perception that it will not be possible to meet future liabilities at a reasonable cost investing only in bonds was corroborated by a study by the Swiss Association of Pension Funds (ASIP). According to ASIP's estimates, given current liabilities and active plan members, a minimum annual return of between 3.25% and 5.0% is required to meet pension obligations; the yield on Swiss government bonds is 2.2% per annum over ten years.

A number of sources, however, indicated that a (partial) shift into bonds might become attractive. One source said, "With the volatility of pension fund assets/liabilities on the balance sheet, a bond strategy would become a very good objective." Another way to address the problem is to change the maturity of the bond portfolio. A rather mature fund with a good coverage rate said, "Shifting into bonds will not be an advantage, but we might consider to tailor a bit more to our liabilities with longer term bonds."

However, a number of sources indicated that a (partial) shift into bonds might become attractive.

There is a perceptible shift out of equities and into bonds in, for example, the U.K., where average equity exposure has gone from 70% to 56%.

There is a perceptible shift out of equities and into bonds in some countries. In the United Kingdom, the need to cover liabilities for defined-benefit schemes which have closed is playing a role. The actuarial consultant Mercer has estimated that among the U.K.'s top 350 quoted firms, the percentage offering defined benefit pension schemes to new employees fell from 64% in 2001 to just 33% two years later.[17] This, together with legislation on mark to market and minimum funding requirements, has seen equity exposure go from a typically high level of 70% to 56% in 2003. This trend is expected to continue until equity exposure reaches levels typical of insurance funds which have a 30/50 split equities/bonds.[18]

There is some concern that a switch out of bonds would have a negative impact on stock markets.

There is some concern that a switch out of bonds would have a negative impact on stock markets. As significant owners of the world's assets, funded pension plans play an important role in financial markets. Pension assets represent more than 60% of the GDP in the Netherlands, Switzerland, the United Kingdom, and the United States. They represent 50% or more of all institutionally held assets in the Netherlands and Switzerland and more than one third of all institutionally held assets in the United Kingdom and the United States. As of end 2001, the share of pension funds in domestic equity holding was 18% in the United Kingdom and 22% in the United States.[19] A significant movement out of the stock markets would have an impact on financial markets. Calculations made by investment banks point to a possible drop in U.S. equity prices in the range of 1%-15%.

There is another development that might have an adverse impact stock prices: demographic trends.

There is another development that might have an adverse impact stock prices: demographic trends. The theoretical assumption that demographic changes might affect stock prices is widely shared, though there is no consensus on how to model this relationship and just what its impact might be. A widely quoted study by Robert Stowe England, Director of Research of the Global Aging Initiative at the Center for Strategic and International Studies in Washington D.C.[20] suggests that in the coming years financial markets will experience a "hard landing". His argument is the following. The progressive creation of funded systems will push stock market valuations up. However, due to the shrinking ratio of workers to pensioners, sometime between 2010 and 2025, defined-benefit pension plans will be forced to disinvest to pay pensions. This disinvestment will create a net outflow of capital out from pension funds[21] and, subsequently, a "hard landing" of financial markets (i.e., a sharp decrease in asset prices). The magnitude of the negative impact of demographics on stock returns has been challenged but the question remains posed.

---

17) *The Economist*, 18 September 2004.

18) IMA, *Asset Management Survey for 2003*, London.

19) IMF, *Global Financial Stability Report*, Chpt III: Risk Management and the Pension Fund Industry, September 2004.

20) Robert Stowe England, "Global Aging and Financial Markets: Hard Landings Ahead", *CSIS Significant Issues Series*, 2002.

21) Obviously there is no net outflow of capital from financial markets at large as every seller needs a buyer. However, selling pressure from large investors can result in significant price drops.

14. ALTERNATIVE ASSET CLASSES

There is much talk of strategies such as hedge funds or alpha portability to boost returns. We asked participants how important these strategies were today and how important they were likely to become. Roughly half of the sources in each country surveyed has made some initial investment (2%-5%) in strategies such as hedge funds or portable alpha. 2 of the 28 sources mentioned having more than 10% of their assets in hedge funds or other high-risk asset classes. Both use a lot of modeling.

Roughly half of the sources in each country surveyed has made some initial investment (2%-5%) in strategies such as hedge funds or portable alpha.

As for the future of these strategies, results were mixed. One fund that has allocated more than 10% of assets to these asset classes said, "Hedge funds, portable alpha and similar strategies to boost returns will become more important given the low-returns environment." However, several funds mentioned that they will be evaluating the returns in these asset classes before making any significant new investments. A source in the U.S. said, "We have been using quite a lot of hedge funds and alpha portability and I believe they will grow over time, but for the moment we have slowed down our investment in these strategies: we are concerned about all the people piling into these asset classes and expect that in a year or two, hedge fund returns will be disappointing; and alpha portability is a zero-sum game." A source in the Netherlands said, "We have just put 2.5% of our assets into hedge funds. We will want to see what this gives in returns before investing any more in these assets." A source n Switzerland said, "We have 2% in hedge funds and this is not likely to grow. If you look at what has been happening recently, everyone is losing money with hedge funds."

As for the future of these strategies, results were mixed; several funds mentioned that they will be evaluating the returns in these asset classes before making any significant new investments.

It is probably fair to say that alpha strategies are used as a second-order adjustment to returns. A source in the U.K. said, "Generating alpha has historically been difficult to do, but we are increasing the use of alpha strategies, using for example equity market neutral strategies. We are trying to build alpha risk into our basically beta-based model. Our thinking is that alpha assumptions might occupy a 2nd order stage of the modeling processes."

It is probably fair to say that alpha strategies are used as a second-order adjustment to returns.

Several very large funds in the United States and the United Kingdom consider that they get their boost from their high equities allocation. One source said, "We don't use any exotic strategies to boost returns. We base our investment strategy on the principle that, in the long term, risk and return are related. As equities have a higher risk, they will generate higher returns... It is the exposure to the underlying asset that counts."

Several very large funds consider that they get their boost from their high equities allocation.

This was echoed by a number of sources that cited the growing importance of the ALM process. One source commented, "In the 1980s and 1990s, returns were more than sufficient to keep up with

Sources cited the growing importance of the ALM process.

the liabilities. In the low-returns environment, the ALM process will become more important." Another source at a large Dutch fund added, "We do not use any alpha; any alpha term is automatically removed from the ALM. You cannot beat the market: there are ups and downs but in the long run there is no premium. ALM is absolutely the key for any pension fund; it almost fully determines the resulting risk." This echoes a study by Brinson et al[22] which showed that asset allocation is responsible for 94% of a fund's performance.

15. ACTUARIAL APPROACHES VERSUS FINANCIAL ECONOMICS

The debate over an actuarial or a financial economics approach has become quite heated recently, especially in view of the consequences on just what asset classes should be preferred.

The debate over an actuarial or a financial economics approach has become quite heated recently, especially in view of the consequences on what asset classes should be preferred. The actuarial approach is that of the insurance industry. It is a "physical" approach insofar as it considers both future income and future liabilities as given "exogenous" uncertain streams of cash. It estimates quantities such as the probability of not being able to pay liabilities, the formation of surpluses, and so on. Besides the mathematical complexities of the stochastic processes involved, it is an intuitive, "common sense" approach. For example, it suggests that a stream of cash flows with a higher expected value at a given time horizon might be preferable to another stream with a lower expected value although the two might have different volatilities. The actuarial approach would suggest that equities might be preferable to bonds because they produce a higher expected return due to the risk premiums.

The financial economics approach observes that all cash flows and assets are ultimately priced in the same market and are therefore subject to financial laws such as the absence of arbitrage. It further observes that a given stream of liabilities can have only one present value and there cannot be two self-financing trading strategies that cover exactly the same stream of liabilities but with different initial investment: this would create arbitrage opportunities.

Proponents of a financial economic approach remark that, at least to a first order of approximation, all financing methods are equivalent. Companies, they claim, fool themselves by thinking that they can reduce the cost of financing pensions by investing in equities. They acknowledge that there might be only second-order effects such as cost of transaction or taxation. This line of thought was originated by two seminal papers by Black and Tepper.[23] A recent influential contribution was made by Exley, Mehta, and Smith.[24]

The financial economics approach is explained in different ways. A first observation is that a dollar of equities has the same value as a

22) Brinson, Hood and Beebower, "Determinants of Portfolio Performance", *Financial Analysts Journal*, July-August 1986.
23) Fisher Black, "The tax consequences of long run pensions policy", *Financial Analysts Journal*, 1980, 36 21-28 and Irwin Tepper, **"**Taxation and Corporate Policy", *Journal of Finance*, 1981, 36 1-13.
24) Exley, Mehta, Smith, 1997, "The Financial Theory Of Defined Benefit Pension Schemes", available at www.gemstudy.com.

dollar of bonds. Though the expected growth of the equity dollar might be higher than the expected growth of the bond dollar, given its higher risk it has to be discounted with a higher discount rate. Another way of presenting the financial economics point of view is that a firm which believes it can reduce its pension costs by investing in equities does not consider that its investment increases the risk of its balance sheet and therefore adversely affects its market price and its cost of capital.

The financial economics point of view is theoretically correct; the debate is due to different interpretations of its consequences and on the role of risk in managing pensions.

The financial economics point of view is theoretically correct; the debate on its applicability is due to different interpretations of its consequences and on the role of risk in managing pensions. First, observe that though it is true that a dollar of equity is worth a dollar of bonds, investors are not indifferent to the two because they have different risk appetites. The risk premium compensates risk for those that have an appetite for risk. The whole investment management game is based on optimizing risk-taking and risk appetite.

What is often obscured is the fact that pensions are *risky*. The financial economics point of view considers liabilities as a given stream of (stochastic) negative cash flows which is the same for all market participants. They say: by offering pensions, a firm acquires a stream of liabilities which has only one price. The investment policy of the firm does not change the final cost of the pension liabilities. What is misleading is the fact that the pension plan is a given flow of liabilities: firms can go bankrupt and default on their pension schemes. By investing in equities as opposed to bonds, firms increase the probability of defaulting on their pension schemes and eventually being forced into bankruptcy, but increase their expected earnings. Risk-taking investors might prefer this behavior.

Things would be different if a government would strictly guarantee pensions, charging a market-based insurance premium. In this case, to a first order, all investments would become equivalent. However, no government strictly guarantees pensions. In addition, in most cases, the closure of a plan is negotiated, with plan members often accepting reduced pensions to avoid bankruptcy of the sponsoring firm.

Lastly, pension liabilities are long-term liabilities and therefore difficult to forecast. It is unlikely that there is a real market consensus on the risk inherent in a pension plan. Markets reward short-term earnings and are less concerned about stochastic liabilities twenty years in the future.

The role of risk in pensions is what makes the financial economics approach so unpalatable.

The unperceived (and perhaps unspoken) role of risk in pensions is what makes the financial economics approach unpalatable to most firms. The strength of the commitment of a firm to its pension plan varies largely from firm to firm. Perfectly in line with financial economics, financial markets perceive this and might reward risk-taking firms.

16. CONCLUDING REMARKS

There is a growing use of computer-based modeling in the pension funds industry. Simply put, the role of modeling is to reduce uncertainty. Pension fund management is subject to many sources of uncertainty: demographic trends, inflation, interest rates, markets, etc. Through a blend of theory and statistical analysis, computer-based modeling reduces uncertainty. Of course one can manage pension funds safely without models, but this would entail building in larger safety margins, which would be costly.

By reducing uncertainty, modeling allows better decision-making. Using powerful modeling tools, management can analyze scenarios and observe, through computer simulations, the future consequences of decisions. In some instances, a full fledged optimization process can be implemented.

The benefits of computer-aided decision-making in the ALM process are clear from this study. Those plans that have implemented a computer assisted decision making process are generally safer and/or more efficient than less sophisticated peers.

Modeling can reduce the uncertainty around managing pensions and likely reduce the costs, but it cannot solve the economics of the pension problem. In the long run, the real cost of pensions depends on demographics and on the contractual arrangements made between generations. Pensions will be paid in full if firms and the economy at large are healthy and the social partners are willing to transfer resources from the active to the inactive population.

APPENDIX

OVERVIEW OF THE LEGISLATIVE FRAMEWORKS OF THE FOUR COUNTRIES SURVEYED

THE NETHERLANDS

In the Netherlands, there are about 900 occupational plans covering roughly 90% of the working population (2001). They have an estimated EUR 442 billion ($591bn) of assets under management. Of this, EUR 141 billion ($188.5bn) are in single-employer pension funds[25]; industry-wide pension plans play a large role in the Netherlands. Employees contribute to the funds; a common ratio is 2/3rd employer, 1/3rd employees. Defined benefit pension funds are separate legal entities, but the new IFRS rules to come in effect in 2005 will require listed companies to include the assets and liabilities of their pension funds in their balance sheets.

Following the sharp correction of equity markets in 2000, the average funding ratio went from a high of 151% in 1999 to 110% in 2002. The government response was to overhaul the regulatory framework, with the objective of ensuring that pension funds remain fully funded at all times. The regulatory minimum funding ratio is 105%. This is composed of 100% of the present value of accrued benefits plus a 5% reserve for general risks. Rules effective in 2003 set guidelines on the parameters used in ALM studies if these studies are used to determine contributions or investment policy: these include a maximum average return on fixed income securities of 5%, a minimum average wage increase of 3%, a minimum average price increase of 2%, and a maximum average risk premium of 3% on equities.

A new set of guidelines for assessing a fund's liabilities and assets which comes into effect in January 2006 will require mark to market and the use of a full set of economic assumptions. The 4% (maximum) actuarial interest rate currently used in the valuation of liabilities is to be replaced by a lower nominal market rate of interest; assets are to be marked to market (if traded) or book value. Actuarial valuations are required on a yearly basis.

Simultaneously, the regulator is introducing a risk-based capital framework similar to that used for banks. The current Actuarial Principles for Pension Funds will be replaced by the Financial Review Framework (abbreviated in Dutch to FTK). Under the new framework, funds will be required to show that their risk of falling below the required 105% funding ratio is no more than 2.5% (i.e., that they risk falling below the 105% funding ratio only once every 40 years). This translates into a VaR of 97.5%. Additional buffers will be required for risky assets: the idea is that pension funds should be able to withstand a drop in the price of risky assets such as equities or real estate.

The Pensions & Insurance Supervisory Authority (DNB/PVK) will review a fund's asset liability matching with stress tests for minimum funding, solvency (one-year time horizon), and long-term solvency or continuity (fifteen-year time horizon). Stress testing will use both shock (a one-time financial event) scenarios and trend (deteriorating circumstances over a number of consecutive years) scenarios. The continuity tests will require the explicit indication of assumptions on short- and long-term interest rates, investment returns, inflation and the like. When a pension fund's own internal model is used, it must be proved to always assess risk correctly and be an integral part of the risk management process.

There are no regulatory limits regarding asset class exposures, however, risky investments require higher reserves. For example, the regulatory solvency buffer on equities is 40% based on the highest

25) "FTK and IFRS to shake-up Dutch pension funds," *Financial Markets Research,* Rabobank International, 8 April 2004.

price in the last 48 months. Average equity allocation has increased from about 10% of total investments in 1990 to 40% in 2000[26] and has remained in the range of 40%-50% since.

According to the 2003 Annual Report of the Dutch regulatory authority DNB/PVK, as of end 2002, Dutch pension funds had a total deficit of asset coverage of over EUR 3 billion ($3.9bn) in terms of nominal liabilities; if required risk reserves were taken into consideration, the reserve deficit totals EUR 37.5 billion ($48.8bn). There is no government guarantee covering pension liabilities. Funds with coverage ratio of less than 100% are required to either bring the ratio to over 105% within one year or to reduce the indexation of benefits.

SWITZERLAND

In Switzerland, there are some 8,000 private-sector occupational funds and another 135 public-sector plans. Many are multi-employer. There are an estimated EUR 293 billion ($386bn) end 2002 or EUR 332.5 billion ($438bn) mid 2004 assets under management in occupational pension funds. The funds are established as legal entities separate from the sponsoring employer. However the new IFRS rules to come in effect in 2005 will require listed companies to include the assets and liabilities of their pension funds in their balance sheets. Funding is based on employer contributions and, frequently, employee contributions. In the case of shared costs, employers must at least match employee contributions; a typical funding ratio is 2:1 (employer / employee). Partial valuation updates are done yearly; a full actuarial valuation/recalculation is required at least every three years.

The use of a static 4% discount rate has been typical. Demographic assumptions are based on public-sector pension fund statistics, tables used by the insurance companies, or, more recently, tables based on the statistics of large private-sector employer-sponsored pension funds (known as the BVG 2000 tables).

The new GAAP FER 26 standards, which will come into effect in the 2005 annual reports of all pension funds, introduce standardized accounts across the Swiss pension fund industry. Assets are to reflect actual value, i.e., market value for securities and capitalizing net income for real estate assets; disclosure of the cap rate and its derivation will be required.

The regulators have not taken a prescriptive approach to modeling. However, there are regulatory limits on asset classes: the objective is to ensure the long-term security of the fund. For example, investment limits in asset categories are 30% in equities (50% when the cover ratio is over 110%), 50% in real estate and 75% in mortgages (wider home-ownership is a goal). Average equity allocation increased from about 13% in 1992 to just under 40% in 2001.

The regulatory coverage ratio is 100% on a termination basis. End 2001, official figures showed that 5.8% of the occupational funds were underfunded relative to a 100% funding ratio. In case of underfunding, a fund is must draw up a plan to return to 100% funding. A Guarantee Fund (financed by premiums paid by the funds) was recently created to offer a (partial) guarantee of benefits in case of insolvency.

26) “Pension Funds at Risk”, CPB Report 2003, CPB Netherlands Bureau for Economic Policy Analysis.

The United Kingdom

In 2000 (latest date for which figures are available), there were some 39,000 private-sector defined-benefit pension plans, covering roughly 30% of the population. They have an estimated EUR 869.4 billion in assets ($1,162bn) in assets. Defined benefit pension schemes are being closed: among the top 350 quoted firms, 64% offered final-salary schemes to new members in 2001; just two years later, the percent of those doing so fell to 33%; it is estimated that 60% of the private-sector defined benefit funds are now closed to new members. Private-sector defined-benefit pensions are funded by the sponsoring employer; in some cases, contributions are also required from employees. The assets and liabilities of the fund are essentially those of the sponsoring employer.

The new Financial Reporting Standard (FRS17), which is expected to come into full effect in January 2005, makes explicit the financial risks of operating a defined benefit plan. It requires that the pension plan assets and liabilities be recognized at fair value on the company balance sheet. Though it still allows discretion, FRS17 is more prescriptive than the actual SSAP24 regarding actuarial assumptions and methodology. (Note that under the SSAP24 the assumptions used in the ALM exercise were considered to be "owned" by the actuary; under the FRS17, they are considered to be "owned" by the plan sponsor.) Liabilities are to be measured at the balance sheet date using the projected unit method and a discount rate reflecting the market yields then available on AA (or equivalent) rated corporate bonds of appropriate currency and term. A full valuation of liabilities is required at least every three years. As for assets, FRS17 requires that they be valued annually at the balance-sheet date at fair (as opposed to actuarial) value. Fair value is defined as mid-market value for quoted securities, open market for property and best estimates for unquoted securities.

There is scope for subjectivity in setting assumptions for forecast returns: the FRS17 calls only for "best estimate", with actuarial advice playing a role. The actuarial profession provides guidance on the description of valuation methods, but no standards for setting the underlying financial assumptions.

There are no regulatory limits regarding equity exposure. Historically equity allocation among the defined benefit pension funds had been in the range of 70%, but due to the recent regulatory changes and weak equity markets, there has been a shift out of equities. The recent *Asset Management Survey for 2003* by the UK's Investment Management Association (IMA) put equity allocation at 56% of total assets (traditionally this figure has been in the range of 70%). The regulator has not taken a prescriptive approach to modeling.

The Minimum Funding Requirement (MFR), which came into effect in 1995, has since been modified; by 2004, calculations used to determine the statutory minimum were modified with the effect of reducing the MFR to somewhere between 50-70% of a fund's guaranteed liabilities. The 2004 Pensions Bill will replace the MFR with a scheme-specific statutory funding objective to be determined by the sponsoring firm and fund trustees. There will be no regulatory minimum; the statutory objective will require that, on the basis of actuarial methods and assumptions used, the scheme should hold assets sufficient to pay its accrued pension provisions as they fall in the future.

The aggregate pension fund deficit for private non-financial firms was estimated to be £60bn as of April 2004[27], down from almost triple the figure at end 2002. The government is setting up the Pension Protection Fund (PPF) scheduled to be effective mid 2005; premiums would be linked to the funding status, with a higher premium for underfunded funds.

27) Confederation of British Industry, *Economic Brief*, April 2004.

The United States

In the US, there is an estimated EUR 1.12 trillion ($1.5tn) in private-sector single- and multi-employer defined-benefit pension funds. From a high of 112,000 plans covering 40% of US workers in the mid 1980s, by 2004 the number of private-sector defined benefit plans shrunk to 31,000, covering 20% of the working population.[28]

Defined-benefit pension plans are funded entirely by the employer. When the sponsor is a corporation, the fund assets and liabilities are part of the company's balance sheet. For financial reporting purposes, liabilities are discounted using a four-year weighted average of long-term high-grade corporate bond yields or about 6.25%. For funding purposes, a higher rate is often used; this is typically the expected return on equities.

Guidelines for assumptions on expected returns are stipulated by the FAS87, which allows for a relatively high degree of subjectivity in setting assumptions. Expected returns on equity investments are widely made with reference to historical returns; the typical figure used recently has been in the range of 8%-9%. The coverage ratio on private-sector pension plans guaranteed by the PBGC is 90% of current liabilities. The investment behavior of the funds is regulated by the Department of Labor (DOL).

There are no regulatory limits regarding exposure to equities or other asset classes. Among the large defined-benefit pension funds, equities account for some 60% of invested assets. The regulators have not taken a prescriptive approach to modeling. The expected rate of return is not broken down by asset class: the FASB requires only an explanation of the basis used to determine the overall expected rate of return on assets, without specifying which specific factors should be included when determining the long-term rate of return on asset assumptions.[29]

A fund is considered to be "fully funded" if up to 90% of "current liabilities" are funded. Insurance is mandatory for private-sector defined-benefit plans and is provided by the Pension Benefit Guaranty Corporation (PBGC), a self-financing federal agency. Insurance premiums are based on the number of plan members, with higher premiums for underfunded plans. When assets drop below 90% of estimated current liabilities for three consecutive years or under 80% in one year, the PBGC requires the plan sponsor to contribute additional assets, not necessarily cash.[30]

In its 2003 Annual Report, the PBGC estimated at $350 billion the funding deficit of private sector single-employer pension plans and $100 billion for multi-employer plans. The PBGC itself is running a deficit: at fiscal year-end 2004, the agency's deficit was $23.3 billion, up from $11.2 billion in 2003; its "reasonably possible" exposure was calculated to be an additional $96 billion.[31]

28) Testimony of Bradley D. Belt, Executive Director of the PBGC, United States Senate Committee on Commerce, Science and Transportation, 7 October 2004.
29) Douglas Fore, "Changes in Accounting Practices Will Drive Pension Paradigm Shift".
30) Gary Shilling, "Pension profits become corporate costs" October 2003.
31) PBGC press release "PBCG Releases Fiscal Year 2004 Financial Results", 15 November 2004.

Table 1 – Summary of data with a bearing on modeling.

	Netherlands	**Switzerland**	**United Kingdom**	**United States**
Liabilities valuation	Standard tables of mortality/disability from Actuarieel Genootschap or insurance companies, based on 5-yearly gov census.	Demographic assumptions based on statistics from public-sector pension funds, insurance companies, or, more recently, large private-sector employer-sponsored pension funds.	Demographic assumptions the choice of actuary, but tax authorities specify a mortality basis for calculating maximum funding level.	Demographic assumptions the choice of actuary.
Discount rate	Static 4% typical; no full set of economic assumptions. 2006 nominal market of interest with full set of economic assumptions.	Static 4% typical; no full set of economic assumptions.	SSAP24: 6.5% typical with full set of economic assumptions. FRS17: Market yield on AA (or equivalent) rated corporate bonds, with full set of economic assumptions. To determine funding for MFR: (with restrictions) expected long-term return on equities.	Different rates can be used for accounting and funding purposes. Accounting rate (temporarily) a 4-yr weighted average of high-grade corporate bond yields. Rate used to determine funding under ERISA typically based on ROA forecasts.
Asset valuation	Market value, book value; no smoothing.	Market value; capitalizing net income value for real estate assets; no smoothing.	SSAP24: Actuarial value FRS17: Market value; no smoothing.	Market value; smoothing over up to 15-yr period.
Frequency of valuations	Yearly.	Yearly; complete actuarial valuation 3-4-yearly.	3-yearly.	N.A.
Asset return forecasts	Regulatory max average return on fixed income 5%. Regulatory max average risk premium on equities 3%.	4%-4.5% typical.	FRS17: based on actual assets held and valued, if bonds, on redemption yield, if equities, best estimate.	Best estimate (typically based on historical returns, 8%-9% typical recently); not broken into assets classes.
Limits on exposure to asset classes	None.	30% equities (50% when coverage ratio >110%) 50% real estate 75% mortgages.	None.	None.
Modeling, regulatory requirements	Stress testing using shock and trend scenarios over 1-yr & 15-yr horizons.	None.	None.	None.

Table 2 – Summary of data on funding issues.

	Netherlands	**Switzerland**	**United Kingdom**	**United States**
Assets in DB plans (estimated)	EUR 442bn ($591bn mid 2003, of which EUR 141bn ($188.5bn) in single-employer plans.	EUR 293bn ($386bn) end 2002; EUR 332.5bn ($386bn) mid 2004; includes public/private 2nd pillar funds).	EUR 869.4bn ($1,162bn)	EUR 1,120bn ($1,500bn) end 2003 (single & multi-employer private sector)
Estimated underfunding (private sector)	EUR 3bn ($4bn) (PVK 2003 Annual Report.	Fully funded.	EUR 87bn ($116bn) non-financial firms schemes only, CBI 4/04).	EUR 337bn ($450bn) (PBGC 2003 Annual Report).
Funding rules	105% coverage ratio (present value of accrued benefits + buffer for investment risks); additional buffer required to cover risky assets. 1 yr to bring up to 105%; 15 yrs to reach long-term solvency ratio.	100% coverage ratio on a termination basis; temporary shortfall admitted under determined circumstances and conditional upon a certified plan to bring coverage back to 100%, including contributions and/or re-negotiated benefits within legal framework.	MFR introduced in 1995, subsequent modifications established MFR at 50%-70% of guaranteed liabilities. To be replaced (mid 2005) by scheme-specific funding requirements to be set by sponsor & trustees; statutory funding objective for schemes to meet pension commitments when due to be paid but will include no regulatory minimum.	Decision to fund a pension plan to a greater or lesser extent considered an economic decision, but mandatory insurance agency PBGC requires 90% funding of "current" liabilities. Contributions (not necessarily cash) required for funds that do not meet target for 3 consecutive yrs or fall below 80% target for 1 yr.
Insurance	No government guarantee.	Guarantee Fund recently created.	PPF in the pipeline; risk-based premium under consideration.	Mandatory for private-sector plans; provided by self-financed federal agency PBCG; > premium for underfunded funds.

Table 3 – Summary of complementary information on DB funds.

	Netherlands	**Switzerland**	**United Kingdom**	**United States**
Status	Separate legal entity.	Separate legal entity.	Most set up under trust.	Trust.
Actuarial funding methods, prevalent	Current unit method, increasingly projected unit method.	Current unit method.	Projected unit method.	Projected unit method.
# of plans/% of working pop covered	900 plans (includes industry-wide plans) covering 90% of the working population.	8,000 private-sector plans (2002) covering a large percent of the working population.	39,300 private sector-plans (of which 1/4th closed to new members), covering c. 30% of the working population (2000).	31,000 private-sector plans covering 20% of the working population.
Contributions	Co-funded employer / employee, typical ratio 2:1.	Co-funded; employer min 50%; typical ratio employer / employee 2:1.	Employer; contribution sometimes required of employee.	Employer only.
Disclosure	Annual report mandatory including info on assets & liabilities for funds with assets >EUR 3.5m.	Swiss GAAP FER 26 reporting standard, includes info on assets & liabilities. Annual accounts and report on demand; members can also request info on risk pattern & method used to determine coverage ratio & benefit reserves.	Annual reports and accounts; full buy out costs on request.	Summary annual report mandatory for plans with >100 members, but need not include info on liabilities.
Board of directors	50/50 employer / employee reps; pensioners to be given representation.	50/50 employer / employee.	Typically 1/3rd employee reps (for plans with > 100 members).	N.A.
Regulatory authority	DNB/PVK.	Decentralized or federal authority.	OPRA, new Pensions Regulator scheduled to take effect mid 2005.	DOL.

Table 4 – Asset Allocation of Autonomous Pension Funds (includes Occupational and Personal Pension Funds) - Years 1992 and 2001, in percent of total financial assets of pension funds:

	Netherlands		**Switzerland**		**United Kingdom**		**United States**	
	1992	*2001*	*1992*	*2001*	*1992*	*2001*	*1992*	*2001*
Cash & deposits	1.9	1.5	10.0	8.5	3.6	3.3	4.5	3.7
Bonds	22.8	34.7	40.5	35.9	9.9	14.5	31.1	23.1
Equities	17.8	49.5	13.1	39.0	74.8	63.5	46.5	59.8
Loans	48.3	8.8	34.8	13.8	0.1	0.0	2.8	1.8
Other	9.2	5.4	1.6	2.9	11.6	18.8	15.0	11.5

NB: Personal pension funds typically have a higher asset allocation in equities than DB funds. For example, figure from the United States put at 53% the percent of DB funds invested in equities on average since 1990 against 60% for DC plans.
Source: IMF, *Global Financial Stability Report,* Chpt III: Risk Management and the Pension Fund Industry, September 2004.

MODELING ISSUES

Economic scenarios are generated taking into account the mutual relationships between economic variables. In this respect, both short-term dynamic and eventual long-term equilibrium relationships are considered. Among the widely used approaches for generating scenarios are the following:

- Nonlinear difference equations, used, for example, in the Wilkie model
- Vector auto-regressive (VAR) and error correction models (ECM), implemented in the Ortec models widely used in the Netherlands
- Stochastic differential equations, used by Tower Perrin's CAP:Link system
- Levy processes in a risk-neutral environment, used in The Smith Model from TSM.

Key issues in the generation of economic scenarios include the following:

- Mean reversion and time diversification
- Cointegration
- Arbitrage opportunities
- Interest rate modeling

Mean reversion is an important (and controversial) property of stock price processes and other economic variables. A mean reverting process is a process that tends to revert to a long-term trend. A random walk might look like a mean reverting process but it is not as it makes unbounded excursions around its trend. A mean reverting price process entails that there is less risk over long time horizons than over short time horizons. Econometric evidence in favor of mean reversion is mixed.

Similar to but different from mean reversion, cointegration means that there are long-run equilibrium relationships between processes; it is therefore meaningful to make linear regressions of one process over the others.[32] A set of processes can be individually unpredictable random walks but at the same time cointegrated. An illustration of this is that of a drunk and his dog. The drunk zigzags about as a random walk; the dog follows its own random walk, but stays close to its master. It has been demonstrated mathematically that the existence of long-run equilibrium conditions (i.e, of cointegration) implies that processes exhibit common stochastic trends, i.e, are driven by common dynamic factors. This last property is of importance for pension planning: it makes a difference whether returns and liabilities are driven by common factors or move about independently.

Error correction models (ECM) explicitly introduce long-term correction terms in a vector autoregression (VAR) model, thus implementing cointegration relationships. A VAR model is a model where the present value of each variable is a weighted average of the past values of all variables. Random changes in model parameters implement structural changes. The same ideas are implemented in stochastic differential equation models and in the Wilkie model mentioned above.

The absence of arbitrage opportunities is a key feature of scenarios. In simple terms, there is arbitrage if two same streams of cash flows are priced differently. If arbitrage opportunities exist, there is no possibility of optimization: one can realize unbounded gains. In practice the absence of arbitrage is ensured by prescribing an "information structure"[33] which results in a tree-like form of scenarios.

32) In a loose sense, one can say that mean reversion is cointegration with a linear trend.
33) An information structure is a set of rules prescribing how information is propagated in a market without anticipation. In a finite setting it implies that scenarios have a tree-like shape; in an infinite setting, typical of stochastic differential equations, information structures are more delicate to define. (see Focardi and Fabozzi, *The Mathematics of Financial Modeling and Investment Management*, Wiley, 2004.)

For each economic scenario, liability scenarios must be generated. The generation of liability scenarios takes into consideration both the state of each pensioner – working, retired, dead, disabled etc – and eventual exogenous changes in the number of pensioners as well as the amount of pension to be paid. For example, Ortec uses a push-pull Markov model that at each step determines, for each plan member, the transition probability to new states. The model also considers the amount of pensions to be paid to each member in each scenario. Liability scenarios are created by aggregation.

ABBREVIATIONS USED

AIMR – Association of Investment Management Research (recently renamed The CFA Institute)
ALM – asset/liability management
ASIP - Association Suisse des Institutes de Prévoyance (Swiss pension funds association)
AUM – assets under management
BVG – in English the Federal Law on Occupational Retirement, Survivors' and Disability Pension Plans, Switzerland (LPP in French)
CBI – Confederation of British Industry
CPB – Dutch Bureau for Economic Policy Analysis
DB – defined benefit
DC – defined contribution
DGP – gross domestic product
DNB - de Nederlandsche Bank, i.e., the Dutch National Bank)
DOL - Department of Labor (USA)
ERISA – Employment Retirement Income Act (USA)
FRS – Financial Reporting Standard (UK)
FTK – Financieel Toetsingskader, in English the Financial Review Framework (NL)
GAAP Generally Accepted Accounting Principles
GDP – gross domestic product
IFRS – International Financial Reporting Standards
IMA – Investment Managers Association (UK)
IMF – International Monetary Fund
MFR – Minimum Funding Requirement (UK)
OPRA – Occupational Pensions Regulatory Authority (UK)
PBCG - Pension Benefit Guaranty Corporation (USA)
PPF – Pension Protection Fund (UK)
PVK – Pensioen Verzekeringskamer, in English, the Pensions & Insurance Supervisory Authority, the Netherlands, to be merged with the DNB - de Nederlandsche Bank, in English - the Dutch National Bank)
ROA – return on assets