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Foreword

The publication that we are pleased to present here is the sum of the first year of work done as part of the EDHEC/AXA Investment Managers (AXA IM) research chair “Regulation and Institutional Investment.”

After an in-depth EDHEC study of the impact of international financial reporting standards and the Solvency II on the financial management of European insurance companies (The Impact of IFRS and Solvency II on Asset-Liability Management and Asset Management in Insurance Companies, Noël Amenc, Philippe Foulquier, Lionel Martellini and Samuel Sender, November 2006), a study done with the support of AXA IM, it became clear to us that the interaction of institutional investment management and regulation was a key issue for European institutional investors.

As a consequence, our subsequent aim was to examine the influence of the institutional and regulatory frameworks on the financial management of pension funds and thus to highlight the challenges posed to institutional investment management by European regulatory developments.

The work involved in covering the impact of prudential and accounting constraints in four major European countries was considerable. I would like to thank my co-authors, Samuel Sender and Lionel Martellini, for the quality of their research and the scope of their efforts.

It is our conviction that the two main conclusions of the study—that the retirement system would be more stable if regulators were more willing to tolerate short-term risk and that pension funds should build internal models for their investment strategies—will have far-reaching consequences on institutional investment in Europe.

AXA IM’s support of this ambitious project has been essential. I would like to thank AXA IM both for the business partnership that enabled production of this publication and for the firm’s dedication to the project. We look forward to developing the analyses and conclusions of this publication in the coming years of the research chair.

We wish you an informative read.

Noël Amenc
Professor of Finance
Director of the EDHEC Risk and Asset Management Research Centre
About the authors

Noël Amenc is professor of finance and director of research and development at EDHEC Business School, where he heads the EDHEC Risk and Asset Management Research Centre. He has a masters degree in economics and a PhD in finance and has conducted active research in the fields of quantitative equity management, portfolio performance analysis, and active asset allocation, resulting in numerous academic and practitioner articles and books. He is a member of the editorial board of the Journal of Portfolio Management, associate editor of the Journal of Alternative Investments and a member of the scientific advisory council of the AMF (French financial regulatory authority).

Lionel Martellini is professor of finance at EDHEC Business School and scientific director of the EDHEC Risk and Asset Management Research Centre. He holds graduate degrees in economics, statistics, and mathematics, as well as a PhD in finance from the University of California at Berkeley. Lionel is a member of the editorial board of the Journal of Portfolio Management and the Journal of Alternative Investments. An expert in quantitative asset management and derivatives valuation, Lionel has published widely in academic and practitioner journals and has co-authored textbooks on alternative investment strategies and fixed-income securities.

Samuel Sender has participated in the activities of the EDHEC Risk and Asset Management Research Centre since 2006, first as a research associate—at the same time he was a consultant to financial institutions on ALM, capital and solvency management, hedging strategies, and the design of associated tools and methods. He is now a full-time applied research manager at the EDHEC Risk and Asset Management Research Centre. He has a degree in Statistics and Economics from ENSAE (Ecole Nationale de la Statistique et de l’Administration Economique) in Paris.
Executive Summary
This study analyses the impact of prudential and accounting constraints on the asset-liability management (ALM) of European pension funds in the Netherlands, the UK, Germany, and Switzerland.

European pension funds are the funded vehicles that support the retirement of an ageing population. Defined-benefit (DB) plans, in which sponsors provide guarantees to employees, are under intense scrutiny from regulators and the financial community, which are seeking to ensure the payment of promised benefits and to measure their true costs.

As illustrated below, pension funds and their sponsors face two main bodies of regulation: accounting standards, which require charging the impact of surpluses and deficits to the P&L of the sponsor, and prudential regulations, which set minimum funding requirements and lay down the conditions for the correction of underfunding.

In what follows, we highlight three main challenges for pension funds, as well as the means by which these challenges may be met:

- The trend toward stricter accounting regulations implies careful management of the accounting volatility from pension funds, with particular attention paid to the accounting discount rate.
- Higher prudential funding requirements cannot be avoided. Stricter minimum funding constraints, i.e., limited allowances for underfunding, can be managed with modern ALM techniques. These techniques also help meet the regulatory requirement for better risk management.
- Pension funds are long-term investors subject to short-term regulatory constraints. Because short-sighted strategies are counterproductive, the challenge for both pension funds and their regulator is to take a long-term approach to investing pension fund assets and to regulating pension funds.

### The impact of stricter accounting regulations

Accounting regulations stipulate that the cost of providing DB pensions be reported in the balance sheet of the sponsor and that shortfalls be amortised in the P&L of the sponsor. In Europe, international accounting standards (IAS 19) require that the fraction of the deficit or surplus that is higher than 10% be divided by the average remaining working life of participants. The British equivalent, FRS Executive Summary

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### Table: Accounting and prudential regulations

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17, does not allow smoothing surpluses and deficits.

IAS 19 requires reporting the projected benefits, a best estimate of liabilities, including any prospective increase in the guarantees (as a result of future wage increases, for instance, or, for hybrid DB plans, of conditional indexation). In addition, projected benefits are discounted at a rate that assumes a credit spread (an AA corporate yield is usually used to discount liabilities).

Worries are that tightening accounting standards will have a great impact on the financial information communicated by sponsors. For instance, were IAS 19 to be aligned with FRS 17, smoothing would no longer be allowed, and under current strategies the cost of providing pensions as reported in P&L accounts would become very volatile.

One of the trends observed in the UK market after the implementation of FRS 17 (the restrictive version of IAS 19) is the closing of DB plans and the opening of defined-contribution (DC) plans. However, this rather extreme solution involves possible dissatisfaction for employees, as they often make poor investment decisions and may also miss the benefits of risk-pooling (protection from longevity and investment risks). Moreover, after closing a DB plan, solutions for existing liabilities must still be found.

The multi-employer exception to IAS 19 means that the balance sheets of the sponsors of industry-wide pension funds are shielded from the impact of surplus volatility. Industry-wide funds, however, are the result of a culture, not of a desire to game regulation. In most cases, then, creating multi-employer pension funds is simply not an option.

Interestingly, because the IAS 19 constraint is mainly a volatility constraint, it can be managed with modern financial tools.

- First, prescriptions in the calculation of the liability must be taken into account in the design of the investment strategy. For instance, we show that as IAS 19 requires spreading, i.e., discounting liabilities at a rate that assumes a credit spread, fixed liability cash flows require a portfolio of forward credit rate agreements as a match.

- Next, modern ALM, also known as dynamic liability-driven investment (LDI), involves three building blocks—the performance-seeking portfolio (PSP), the liability-hedging portfolio (LHP), and the cash account—and requires in particular diminishing the allocation to risk when the funding constraint becomes binding. The LHP—the projection of liabilities over tradable assets—is the risk-free portfolio for the ALM investor. In other words, it is the portfolio of assets that generates the least risk for the pension fund, given its liabilities. Modern ALM permits the management of funding constraints; for instance, it is possible to reduce the likelihood that the funding ratio will breach the 90-110% range beyond which surpluses and deficits impact the P&L of the sponsor.

- Because of the costs associated with developing models that allow the implementation and monitoring of these modern ALM approaches, fiduciary management is an advantageous option for small and medium-sized pension funds.
• Finally, actuarial risks cannot be efficiently managed, as effective means of transferring longevity risk to the capital markets have yet to be found.

The impact of stricter prudential regulations
Prudential regulations set the funding (capital) requirements for pension funds. They apply to all pension funds and their sponsors, regardless of their status and organisation. Multi-employer pension plans as well as state-driven funded pension plans must comply with prudential regulations.

The European directive for pensions
European regulations are bound by the 2003 IORP framework directive (Directive 2003/41/EC on the activities and supervision of institutions for occupational retirement provision), which lays down the following four principles.

• Technical provisions are a prudent valuation of accrued benefits, i.e., the value of the benefits available for a participant in the event his employer declares bankruptcy and the pension plan is closed.
• Some flexibility in funding requirements is provided as underfunding is allowed for “a limited period of time”.
• Underfunding requires a realisable recovery plan.
• The “prudent person” rule, not quantitative restrictions, applies to investments.

The translation of the framework directive into domestic regulations varies greatly from one country to another, in particular for the first two principles:

• Valuation of accrued liabilities is based on a variety of discount rates. In the UK and Switzerland, discount rates may be set according to the expected rate of return on the assets. In the Netherlands, the swap rate is used; UK protected rights are discounted at a government bond yield. In Germany, the discount rate is below the long-term government bond yield, and is almost fixed.
• The required duration of recovery plans varies greatly. The minimum duration in the Netherlands is three years and the average in the UK is 7.5 years.

A shift toward Solvency II?
One of the initial goals of the directive was to facilitate the creation of cross-border pension plans. As domestic prudential regulations are very diverse, revisions to the IORP directive are being discussed.

One of the main outside references is the coming prudential regulation for insurance companies, Solvency II. Solvency II is the most accomplished example of risk-based regulation, as capital requirements—defined as the value of assets over that of liabilities—are set according to a 99.5% one-year Value-at-Risk target and approximation. Applying Solvency II to pension funds would initially raise funding requirements:

• Solvency II requires financial buffers on top of fully funded liabilities.
• The great variety of protection mechanisms enjoyed by pension funds reduces their need for capital. However, the standard formula will not be able to capture these mechanisms and will demand an exaggerated funding ratio.

Solvency II, however, may provide great incentives to build internal models, a feature we view as favourable to the...
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development of sound risk-management practices.

The impact of higher funding requirements
Higher requirements involve an immediate increase in funding ratios and thus require additional contributions. The risk is that these contributions will be perceived as a direct and unwelcome cost and result in knee-jerk closures of DB schemes.

Higher funding requirements would thus be hard to avoid. As mentioned for accounting constraints, creating DC plans does not mean that the DB plan no longer has to comply with regulation, even when the plan is closed to new members.

Fully avoiding prudential regulations requires getting out of defined benefits altogether: in the buy-outs, the pension sponsor transfers the pension fund's balance sheet, together with its commitments, to a third party, generally an insurance company. Sponsors thus reduce the threat of unwanted future regulatory ramifications—accounting or prudential. The wave of buy-outs in the UK is revelatory of sponsor attitudes toward regulation.

The impact of stricter minimum funding constraints and the importance of the prudential discount rate
Higher funding requirements, of course, involve immediate additional contributions to all pension funds and cannot be avoided. By contrast, stricter funding requirements involve improved monitoring of minimum funding constraints rather than immediate additional contributions. Stricter funding requirements can thus generally be managed (just as accounting volatility can be) with modern ALM.

The regulatory discount rate must be highlighted in the design of the investment strategy. When the regulatory constraint is binding—perhaps because the funding ratio is low and neither sponsor nor employees are willing to make additional contributions—pension funds may be forced into prudent or even risk-free investment strategies, risk-free, that is, from the prudential regulator’s point of view. In this case, asset allocation will not merely need to take into account the presence of this constraint; instead, it will be governed entirely by the regulatory LHP.

The current trend is to use the swap yield curve for discounting. For very long-term maturities, the swap market is more liquid than the market for government debt. As such, swaps are the preferred hedging instrument for very long-term liabilities and the swap curve is becoming the standard for discounting. Two historical standards, still used today, are worth considering as well.

The fixed discount rate:
Historically, most countries have used fixed rates to discount liabilities. The Netherlands used a fixed 4% discount rate, Germany a 6% rate for book-reserved pensions, and now the 2.25% for Pensionsfonds (and Pensionskassen) is almost fixed.¹

In this case, the value of liabilities is totally independent of market interest rates. When the bond portfolio is marked to market, the portfolio that immunises

¹ - The German discount rate is not totally fixed. It represents 60% of the ten-year average of the long-term German government bond yields.
the funding ratio against movements in financial markets (mainly interest rate movements) is ... the cash account or, when regulatory reporting takes place every year, the one-year zero-coupon bond.

Discounting at an equity risk premium: Discounting liabilities at an equity risk premium (ERP) means under-estimating these liabilities. From a regulatory perspective, discounting at an equity return is an unsophisticated way to allow pension funds to take risks.

The traditional practice of discounting at an ERP is pro-cyclical, i.e., it amplifies the impact of the business cycle on the financial health of the pension fund. Many financial institutions have been using a historical estimate of the risk premium, computed over a period of say fifteen years (between ten and thirty years, sometimes depending on the maturity of the liabilities). This practice, without any further analysis, may lead to the "equity risk premium trap", i.e., the risk of being trapped in permanent underfunding after market downturns.

After all, when the value of assets falls, so do historical estimates of the risk premium. Falls in expected returns trigger a further rise in the reported value of the liability, and therefore further lower the funding ratio, involving a second round of adverse consequences on the reported health of the pension fund.

In regulations that tolerate or encourage discounting liabilities at a risk premium, we strongly recommend practitioners to use forward-looking equity risk premiums, based on the valuation of the stock market rather than on historical excess returns. Because the forward-looking ERP increases when past performance falters, it follows that the forward-looking measure is counter-cyclical.

The role of internal models in risk-based regulations
Risk-based regulations are meant to foster the development of good risk management practices. In the Basel accords, risk management is simply a qualitative obligation. In Solvency II, incentives for good risk management are such that capital requirements can be measured with internal models, so that the risk of insolvency or underfunding is limited to 0.5% per year for insurance companies. Internal models must be used to manage and control risks and are thus best defined not as risk measurement software but as a full risk management system.

The Solvency II framework has been applied to pension funds in the Netherlands. Other countries may follow. Pension funds facing risk-based prudential regulations will greatly benefit from building internal models and having them approved for the purpose of setting funding requirements. Doing so will enable them to have funding requirements more closely aligned with the nature of their risks and to enjoy reduced quantitative requirements when they have risk-mitigation techniques and instruments unrecognised in the standard formula. (For instance, when risk management relies on these models to reduce the likelihood of underfunding, a smaller capital buffer is required. Pension funds would do well then to develop internal models that rely on modern ALM principles.) In addition,
when internal models show that there is significantly less risk over the medium term than over the short term, as with real liabilities, funding requirements will be reduced.

**The impact of short-term regulatory constraints on long-term risk management**

The horizon for risk measurement tends to be short, whereas pension funds are very long-term investors. As it happens, traditional wage-indexed pension plans illustrate perfectly well why short-term regulations, either accounting or prudential, may be counterproductive.

**Pension funds as long-term investors**

First, pension funds are not commercial entities so in general they do not go bankrupt. Nor do they face the risks (of client runs or massive surrenders) that shorten the investment horizon in insurance companies and banking corporations and make an assessment of risk over relatively short horizons mandatory.

**A replicating strategy for long-term, traditional liabilities**

For wage-indexed liabilities, we analyse the liability-hedging portfolio (LHP), which, obtained by projecting liabilities on tradable assets, is the portfolio of assets that generates the least risk for the pension fund.

In the long run, real assets such as equities are needed to replicate wages. After all, wages, like equities, are linked to overall economic performance. Wages and earnings can be understood as a share of economic output, so equity valuations that exhibit a long-term average or move within a range would allow a stable long-term relationship between wages and equity prices.

As detailed further in section III of the study, wages and equities are co-integrated, that is, they are trended series with strong long-term dependency. In addition, as shown in the OECD’s business cycle indicators, equities are a leading indicator of the business cycle, whereas wages are a lagging indicator.

These stylised facts allow us to run a specific model in which equities help predict wages but wages do not help predict equities. Our stylised model makes possible an analytical computation of the LHP—the projection of the liability over the universe of tradable securities, here over equities alone. The replicating strategy involves a time-dependent allocation to equities, starting with high weights (close to one for very long horizons), and gradually falling to 12%, the short-term relationship between equities and wages (a change of 1% in equities leads to a 0.12% change in wages).

Because of co-integration, the passage of time makes wages replicable. In the short term, wage exposure is essentially not replicable, but as time passes it is. And because wages become replicable over time, the annualised volatility\(^3\) of a pension fund that uses the replicating strategy described here falls over time. The 1.4% annualised volatility at maturity for a fifty-year wage-indexed liability must be compared with the constant 15% volatility for equity holdings in asset management.

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3 - The annualised volatility is defined as total volatility divided by the square root of the time.
Over long horizons, after all, only non-replicable risk remains.

A long-term view involves short-term risk, whereas a short-sighted strategy involves increased risk over the long term. The situation is very different in the early years, during which great equity exposure results in great volatility in the funding ratio and consequently in the sponsor’s accounts.

Regulations and accounting standards that focus on short-term figures are incentives for short-sighted investments, especially for weaker sponsors or the least well funded pension plans. However, short-sighted strategies in the case considered here imply ever-greater long-term volatility.

Short-sighted strategies involve investing in equities in accordance with their short-term relationship to wages, ignoring the longer-term dependencies. In practice, this short-sightedness means a constant equity weight of 12% to cover wage-indexed liabilities.

Because wage-indexed liabilities mean great exposure to the economy, and because in the current model exposure to the economy can be achieved only through equity investments, the 12% exposure to the economy on the asset side is not sufficient to cover the liabilities. As a consequence, risk builds up on the liability side for the short-sighted investor and annual volatility rises. So, short-term strategies lead to an accumulation of risk over the long run. In addition, a careful examination would show that the expected return of bond-like strategies would be insufficient to cover the rise in wage-indexed liabilities.

Figure 2: Annualised volatility induced by the replicating strategy
The replicating strategy that minimises risk over a defined horizon (here, fifty years) is a time-dependent strategy involving equity investments. Equity holdings involve a significant amount of risk over the short run, as equities are volatile whereas wages are sticky.
The ramifications for both accounting and prudential regulations are:

- We strongly recommend that IAS 19 tolerate some volatility in the funding ratio for wage-indexed liabilities. In this respect, alignment with FRS 17 would be counterproductive.
- Risk-based prudential regulations, which require buffers as a function of risk taken in pension funds, should base their measures of risk on the long-term volatility of ALM strategies—not the short-term volatility.

There are also ramifications for pension funds. As they need real assets to generate real liabilities, they must develop the techniques and models for efficient long-term investing and prove to regulatory bodies that they have mastered a long-term approach to managing their risks. As a result, internal models must be developed.

**Conclusion**

First, accounting standards and prudential regulations are tightening, requiring greater attention to the volatility of the surplus and less tolerance of underfunding.

These changes call for an improvement in ALM strategies and the use of state-of-the-art models—such as dynamic liability-driven investments—for the design of these strategies. An understanding of the constraints to which pension funds are subject is essential to building efficient ALM strategies:

- The portfolio that minimises regulatory risk should take into account the regulatory discount rates.
- Rebalancing rules should depend on the surplus and be based on insights from dynamic asset allocation concepts and portfolio insurance techniques.

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Figure 3: Annualised volatility induced by a short-term strategy

Short-term risk-free strategies involve a very limited amount of equities on the asset side. Risk accumulates over the long run, as wages are linked to the economy.
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- Modelling should capture the specific risk-mitigation mechanisms available to the pension fund, such as conditional indexation, variable contributions, support from the sponsor, modification in asset allocation, support from pension insurance schemes.
- The practice of risk management should be developed, that is, understanding and monitoring the various risk factors faced by pension funds and the design of appropriate responses to changes.

Second, specific attention should be paid to the long-term nature of pension funds. In our view, the replication of wage-indexed liabilities perfectly illustrates the coming challenges for both regulatory bodies and pension funds. These traditional pension liabilities have low short-term replicability, and risk-free long-term strategies involve short-term risk. As a consequence, and because of their role in providing very long-term benefits, the increasing focus on the short term is worrying for pension funds.

Liabilities that are far more easily replicated over the long term naturally need long-term analyses and risk management practices.

The idea that risk management is best reflected in an internal model is especially relevant for pension funds; after all, no standard formula can capture the diversity of the pension landscape and the variety of protection mechanisms.

Most recent regulation permits the use of internal models for the definition of solvency requirements after regulatory approval. This authorisation is present in Solvency II and the Dutch prudential regulation and to some degree in UK regulation. Approval is conditioned primarily on the use of internal models in the following fields: design of investment strategies, risk monitoring and limit setting, definition of the indexation policy, contribution and funding policy (planning). When these conditions are met, the funding requirements made of pension funds will be aligned with the nature of their risks—in particular, funding requirements will be reduced when pension funds use risk-mitigation techniques and instruments unrecognised by the standard formula (dynamic strategies, long-term investing).

In a word, accounting and prudential regulations are threatening to make DB pension schemes more costly. Our study concludes that dynamic ALM techniques and the development of internal models, understood as regulatory-compliant risk-management systems may mitigate some of this risk.
Cette étude analyse l’impact des contraintes prudentielles et comptables sur la gestion actif-passif (l’ALM) des fonds de pension aux Pays-Bas, au Royaume-Uni, en Allemagne et en Suisse.

Les fonds de pension européens sont les fonds d’investissements qui accumulent l’épargne destinée à la retraite d’une population vieillissante. Les fonds à prestations définies (DB), qui permettent aux employeurs de garantir un niveau et une évolution des retraites à leurs salariés, sont fortement réglementés dans le but de sécuriser les engagements pris à cet égard par les employeurs vis à vis des salariés ; ils sont soumis à un examen critique très poussé de la part de la communauté financière qui cherche à mesurer le coût réel des engagements relatifs aux retraites.

Comme illustré ci-dessous, les fonds de pension et leurs sponsors sont confrontés à deux principales réglementations : les normes comptables qui exigent la reconnaissance des surplus et des déficits dans le compte de résultat du sponsor et la réglementation prudentielle qui définit les exigences de provisionnement minimales ainsi que les actions de rétablissement à mener en cas de sous-provisionnement.

Dans ce qui suit, nous mettons en évidence trois défis principaux pour les fonds de pension, ainsi que les moyens de répondre à ces défis:

- La réglementation comptable plus stricte implique une gestion rigoureuse de la volatilité comptable des fonds de pension, avec une attention particulière aux taux d’escompte AA des normes IAS 19.
- Les exigences prudentielles plus élevées de provisionnement ne peuvent être évitées. Les contraintes minimum plus strictes, c’est-à-dire, la tolérance plus faible pour les déficits, peuvent être gérées avec les techniques modernes de gestion actif-passif. L’application de ces techniques permet également de satisfaire les exigences réglementaires d’une meilleure gestion des risques.
- Les fonds de pension sont des investisseurs de long terme sujets à des contraintes de court terme. Les stratégies court-termistes étant contre-productives, le défi pour les fonds de pension est d’adopter une perspective de long terme dans les stratégies d’investissement ; le défi pour leurs régulateurs est d’adopter une approche de long terme de la régulation.

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Figure 1 : la comptabilité et les règles prudentielles

Résumé
L’Impact de règles comptables plus strictes
La réglementation comptable stipule que le coût des prestations définies (DB) doit être déclaré dans le bilan du sponsor et que les déficits doivent être lissés dans son compte de résultat. En Europe, les normes comptables internationales (IAS 19) stipulent que la fraction du déficit ou un excédent qui est supérieur à 10% soit divisé par le nombre moyen restant d’années travail des adhérents. La norme britannique équivalente, FRS 17, ne permet pas le lissage des surplus et des déficits.

IAS 19 définit les engagements actuariels comme les passifs prévisionnels, une estimation du passif à son coût probable (best estimate), y compris les perspectives d’accroissement de la garantie (par exemple du fait des augmentations de salaires à venir, ou, pour les plans hybrides, du fait de l’indexation conditionnelle). Ces passifs prévisionnels sont actualisés à un taux de crédit AA.

Le renforcement des normes comptables et son impact potentiel négatif sur la communication financière des entreprises constitue un sujet de préoccupation. Si la norme IAS 19 s’alignait sur FRS 17 et supprimait les possibilités de lissage dans les comptes, l’estimation du coût des prestations retraites tel qu’enregistré dans les comptes de résultat deviendrait très volatile, et l’ensemble du compte de résultat le deviendrait parfois.

Une des tendances observées sur le marché britannique après la mise en œuvre de FRS 17 est la fermeture pure et simple des plans à prestations définies (DB) et l’ouverture de plans à contributions définies (DC). Cette solution plutôt extrême implique le risque d’une très forte insatisfaction des salariés, car non seulement ceux-ci sont souvent des gestionnaires peu avisés, mais en outre, dans ce cas, ils ne peuvent plus bénéficier de mécanismes de partage des risques (les plans DC ne permettent partage ni du risque de longévité entre adhérents, ni du risque d’investissement entre générations d’investisseurs). En outre, même après la clôture d’un plan DB, des solutions de gestion du risque pour les engagements existants doivent encore être trouvées.

Les plans multi-employeurs bénéficient d’une exception à la norme IAS 19, les passifs n’étant pas reportés au bilan de leurs sponsors à qui la volatilité du surplus importe peu. Il convient de souligner que ces fonds multi-employeurs sont issus d’une culture sectorielle, et ne résultent pas d’une ingénierie financière désireuse d’échapper à la réglementation. En pratique, la création de fonds multi-employeurs n’est en général pas une option possible pour gérer les contraintes comptables existantes.

Fait intéressant, la norme IAS 19 implique essentiellement une maîtrise de la volatilité qui peut être gérée avec des outils financiers modernes.

• Tout d’abord, les prescriptions réglementaires pour le calcul des engagements de retraites doivent être prises en compte dans la conception des stratégies d’investissement. Par exemple, la norme IAS 19 exigeant l’actualisation des passifs à un taux d’obligations notées AA, des flux de passifs fixes nécessitent la mise en œuvre d’un portefeuille de couverture à base de forward credit rate agreements.
• Ensuite, les techniques modernes d’ALM, ou dynamic liability-driven investments (LDI), impliquent une allocation dynamique à trois blocs : le portefeuille de recherche de la performance (performance-seeking portfolio, PSP), le portefeuille de couverture (liability-hedging portfolio, LHP), et le compte de trésorerie. L’exposition aux risques doit être diminuée lorsque le surplus diminue. Le LHP, la projection du passif sur l’ensemble des actifs négociables, est le portefeuille sans risque pour des investisseurs ALM. En d’autres termes, c’est le portefeuille d’actifs qui génère le moins de risques pour les fonds de pension, compte tenu de leur passif. Les techniques modernes d'ALM permettent la gestion des contraintes de provisionnement, par exemple, il est possible de réduire la probabilité que le ratio de provisionnement s’écarte de la fourchette 90-110% au-delà de laquelle les excédents et les déficits impacteront le compte de résultat du sponsor.
• En raison des coûts associés à l’élaboration de modèles qui permettent la mise en œuvre et le suivi de ces approches modernes de gestion actif-passif, la gestion fiduciaire est une option avantageuse pour les fonds de pension de taille moyenne.
• Enfin, les risques actuariels ne peuvent pas être gérés de façon efficace, car des solutions efficaces pour le transfert du risque de longévité vers les marchés de capitaux restent à définir.

L’impact de règles prudentielles plus strictes
La réglementation prudentielle détermine les exigences minimales de provisionnement (capitalisation) pour les fonds de pension. Ces exigences s’appliquent à tous les fonds de pension et à leurs sponsors, y compris aux fonds multi-employeurs ainsi qu’aux régimes de retraites publiques financés par capitalisation.

La directive européenne sur les institutions de retraites professionnelles
La directive-cadre européenne de 2003 sur les institutions de retraites professionnelles (Directive 2003/41/EC on the activities and supervision of institutions for occupational retirement provision, IORP directive), établit les quatre principes suivants :
• Les provisions techniques résultent d’une évaluation prudente des engagements en cours de service (accrued benefits), c’est-à-dire, de la valeur des prestations acquises, pour un bénéficiaire, telles qu’elles seraient figées en cas de faillite de l’employeur et de fermeture du régime de retraite.
• La directive prévoit une tolérance pour le sous-provisionnement, à condition qu’il n’y ait de déficits « qu’à titre temporaire ».
• Le sous-provisionnement implique un plan de redressement « concret et réalisable ».
• Leurs actifs doivent être placés conformément au principe de prudence (« prudent person rule »), et non selon des restrictions quantitatives.

La transposition de la directive-cadre en droit national a donné lieu à de fortes variations d’un pays à l’autre, en particulier en ce qui concerne les deux premiers principes :
• L’évaluation des provisions techniques se fait selon des hypothèses de taux d’actualisation très différents. Au Royaume-Uni et en Suisse, les taux d’actualisation peuvent être fixés selon le taux de rendement attendu des actifs. Aux Pays-Bas, c’est le taux de rendement du marché des swaps qui est utilisé ; au Royaume-Uni, les droits minimaux garantis sont actualisés au taux à 10
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ans des obligations gouvernementales. En Allemagne, le taux est inférieur aux taux gouvernementaux à long terme, et est quasiment fixe.

- La durée des plans de redressement est très variable. La durée minimum aux Pays-Bas est de trois ans et la moyenne au Royaume-Uni est de 7,5 ans.

Un évolution vers Solvabilité II ?
L’un des premiers objectifs de la directive est de faciliter la création de régimes de retraites transfrontaliers. Les réglementations prudentielles nationales sont très hétérogènes et ne facilitent pas l’établissement de tels régimes supranationaux, aussi l’opportunité d’une révision de la directive IORP fait-elle l’objet de discussions.

Dans le cadre de ces discussions, la principale référence utilisée est la prochaine réglementation prudentielle pour les compagnies d’assurance, Solvabilité II, car c’est la réglementation la plus aboutie se fondant sur la mesure du risque. Les fonds propres exigés – définis comme la valeur nette requise – doivent représenter 99,5% de la valeur à risque à horizon d’un an avec un seuil de confiance de 99,5% (Value-at-Risk annuelle à 99,5%). L’application de Solvabilité II aux fonds de pension aurait comme première conséquence d’élèver le niveau de provisionnement requis:

- Solvabilité II exige non seulement un provisionnement total, mais du capital supplémentaire « tampon ».
- La grande diversité des mécanismes de protection et de diminution du risque dont bénéficient les fonds de pension doit d’un point de vue théorique réduire leurs besoins de provisionnement. Cependant, la formule standard ne permettra pas la prise en compte de l’ensemble de ces mécanismes de réduction du risque et aboutira donc à une exigence de niveau de provisionnement exagéré.

Solvabilité II, toutefois, donnerait vraisemblablement de fortes incitations à la construction de modèles internes, ce que nous jugeons de manière très favorable car ils permettent la mise en place de saines pratiques de gestion des risques.

L’impact de l’augmentation des besoins de provisionnement
Un accroissement des exigences de provisionnement entraîne un versement immédiat supplémentaire au fonds de pension ou une augmentation de contributions, ceci de manière généralisée car les règles prudentielles s’appliquent à tous les fonds de pension. Les exigences de contributions supplémentaires sont un coût direct qui, dans le mesure où il résulte d’une modification des exigences réglementaires, n’est pas anticipé, et peut susciter des réactions négatives de la part des sponsors, avec le risque d’une fermeture pure et simple des fonds à prestations définies.

Nous rappelons également que les fonds de pension ne pourront contourner un potentiel accroissement des exigences de provisionnement : comme mentionné plus haut dans le cas des contraintes comptables, même dans le cas de la fermeture des régimes de retraites à prestations définies à de nouveaux membres (et de leur remplacement par des régimes à contributions définies), les engagements passés doivent toujours être à la fois provisionnés et gérés. A moins bien sûr de recourir au buy-out, c’est-à-dire au rachat de l’ensemble du bilan du fonds de pension (actifs et passifs compris) par une tierce partie,
généralement une compagnie d’assurances, qui en assumera tous les risques y compris celui d’un changement futur de la réglementation.

Au Royaume-Uni, la vague de fermetures de plans à prestations définies, ainsi que les buy-outs sont révélateurs d’une perception négative des évolutions réglementaires par les employeurs.

L’impact de ratios minimaux de provisionnement plus stricts et l’importance de la prise en compte du taux d’escompte réglementaire dans la politique de placement

Nous avons vu que si l’augmentation quantitative des exigences de provisionnement ne peut généralement être géré par des techniques financières, un respect plus strict des niveaux minimums de provisionnement, soit le respect de limites de risque plus strictes, peuvent en revanche l’être grâce aux techniques modernes d’ALM, de la même manière que peut l’être la volatilité au bilan.

Nous soulignons l’importance de la prise en compte du taux d’escompte réglementaire dans la conception de la stratégie d’investissement. Lorsque la contrainte réglementaire est prégnante, par exemple quand le ratio de provisionnement est faible et qu’employeur et salariés ont des contraintes budgétaires qui ne les disposent pas à des contributions supplémentaires, les fonds de pension doivent alors adopter des stratégies d’investissement qui réduisent la probabilité de contributions supplémentaires (suite à sous-provisionnement en norme prudentielle).

Dans ce cas, la réglementation fait plus qu’influer sur les stratégies d’investissement, elle les dirige.

La tendance actuelle est d’utiliser la courbe de taux swap pour actualiser les engagements. Pour les échéances très longues typiques des engagements de versement de pensions, le marché des swaps est plus liquide que le marché de la dette publique. En raison de leur plus grande liquidité, les swaps sont le meilleur instrument de couverture des risques du taux à très long terme, et la courbe swap est en train de devenir la norme pour l’actualisation. Il convient cependant de considérer les deux normes historiques suivantes, encore utilisées aujourd’hui :

Le taux d’escompte fixe: Historiquement, la plupart des pays escomptaient les passifs à taux fixe. Les Pays-Bas utilisaient un taux fixe de 4% et l’Allemagne un taux de 6%. En Allemagne, le taux actuel en vigueur, de 2,25% pour les Pensionsfonds (et Pensionskassen) est presque fixe1.

Quand les engagements sont escomptés à taux fixe, leur valeur est presque totalement indépendante des taux d’intérêt du marché. Lorsque les obligations au bilan sont en valeur de marché et que leur sensibilité est prise en compte (alors que celle du passif ne l’est pas), il faut alors, pour immuniser le bilan des obligations de maturité très courte (équale à l’échéance du prochain état prudentiel, donc toujours moins de trois ans) alors même que le passif a une maturité bien supérieure.

1 - Le taux d’escompte allemand n’est pas totalement fixe. Il est égal à 60% de la moyenne sur 10 ans du taux des obligations long terme de l’état allemand.
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Taux incluant une prime de risque actions : L'actualisation des passifs à un taux incluant une prime de risque actions (equity risk premium, ERP) implique une sous-estimation de ces engagements par rapport à leur juste valeur. D’un point de vue réglementaire, l’utilisation d’une prime de risque actions pour la valorisation des passifs est sans doute une manière traditionnelle mais rustique de permettre aux fonds de pension de prendre des risques.

Cette pratique traditionnelle est pro-cyclique, c'est-à-dire qu'elle amplifie l'impact du cycle économique sur la santé financière des fonds de pensions. De nombreuses institutions financières ont calculé une prime de risque historique, calculée comme le différentiel de performance historique des actions par rapport aux obligations sur une période comprise généralement entre 10 et 30 ans (parfois en fonction de la maturité du passif). L'utilisation d'une prime de risque historique pour la valorisation des passifs, du moins sans analyse complémentaire, a sans doute piégé de nombreux fonds dans une situation de déficit chronique suite à une forte baisse des marchés d'actions.

Après tout, lorsque la valeur des actifs diminue, il en va de même de la performance historique relative des actions, aussi une chute de la valeur des actifs fait-elle baisser le taux d'escompte des passifs et, faisant apparaître ceux-ci plus chers, détériore d'avantage le ratio de provisionnement, parfois plus que ne l’avaient envisagé les utilisateurs d’une prime de risque actions historique.

Là où les réglementations prudentielles autorisent l’inclusion d’une prime de risque pour la valorisation des passifs, nous recommandons vivement aux praticiens d’utiliser une prime de risque prospective, basée sur l’évaluation de la valorisation des cours boursiers, plutôt qu’une prime de risque historique, basée sur la performance passée des actions. En effet, la prime de risque actions prospective augmentant lorsque le cours des actions chute, cette mesure de la prime de risque est contre-cyclique et a des effets stabilisateurs sur le taux de provisionnement et la gestion des fonds de pension.

Le rôle des modèles internes dans les réglementation basées sur le risque (risk-sensitive)
Les réglementations basées sur le risque (risk-sensitive) ont pour but de favoriser le développement des bonnes pratiques de gestion des risques. Dans les accords de Bâle, la gestion des risques n’est qu’une obligation qualitative. Dans Solvabilité II en revanche, afin d’inciter les compagnies d’assurance à une bonne gestion des risques, les besoins en capitaux peuvent être estimés avec les modèles internes. Ceux-ci doivent non seulement être calibrés avec une probabilité de ruine à un an de 0,5%, mais doivent également être utilisés pour gérer et maîtriser les risques. Les modèles internes se définissent donc comme systèmes de gestion des risques plutôt que comme outils de mesure des risques.

L'architecture Solvabilité II a été transposée pour les fonds de pension aux Pays-Bas², et d’autres pays sont susceptibles de suivre cet exemple. Ces réglementations fondées sur les risques créeront de fortes incitations à construire des modèles internes, ce qui leur permettra une réduction des exigences quantitatives de provisionnement, et ceci d’autant
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plus que les garanties et techniques de réduction des risques dont ils disposent seront vraisemblablement mal reconnues dans la formule standard. Ce sera le cas en particulier s’ils adoptent dans le même temps les techniques ALM modernes. Ce pourrait également être le cas s’ils démontrent que le risque qu’ils portent sur le long terme est inférieur au risque court terme, comme ce peut être le cas quand des actifs réels sont utilisés pour répliquer l’indexation sur les prix à la consommation ou sur les salaires.

L’impact de contraintes réglementaires court terme sur la gestion des risques de long terme
Si le risque est très généralement mesuré sur un horizon court, les fonds de pension sont des investisseurs de très long terme. Le cas de retraites indexées sur les salaires illustre parfaitement les limites de régulations comptables et prudentielles de court terme.

Les fonds de pension comme des investisseurs de long terme
Tout d’abord, les fonds de pension ne sont pas des entités commerciales et en particulier ne peuvent eux-mêmes pas faire faillite. Ils ne sont pas non plus exposés au risque de liquidité par fuite des passifs, retraits massifs des dépôts bancaires ou crise de rachat dans l’assurance, qui peut amener ces sociétés commerciales à la faillite, ce qui exige la prise en compte des risques de court terme et réduit logiquement leur horizon de placement.

Une stratégie de réplication de long terme pour les passifs traditionnels indexés sur les salaires
Pour les retraites indexées sur les salaires, on analyse le portefeuille de couverture (LHP) est le portefeuille qui génère le moins de risques pour les fonds de pension. Il se définit mathématiquement comme la projection des facteurs de risques du passif sur l’ensemble des actifs négociables.

Sur le long terme, il est nécessaire d’investir dans des actifs réels tels qu’actions ou immobilier pour répliquer l’évolution des salaires. En effet, l’évolution à long terme des salaires, comme celle des actions, est liée à la performance économique globale. Les salaires comme les bénéfices des entreprises sont la rémunération des facteurs de production dans l’économie, et sont une part stable de la valeur ajoutée, aussi suffit-il que les valorisations soient stables et évoluent dans une fourchette sur le long terme pour qu’il y ait également une relation stable entre salaires et prix des actifs.

Ainsi que nous le détaillons dans la section III de notre étude, les salaires et les actions sont effectivement co-intégrés, c’est-à-dire qu’ils exhibent une forte dépendance sur le long terme. En outre, comme le montrent les indicateurs du cycle économique de l’OCDE, les actions sont un indicateur avancé du cycle, tandis que les salaires en sont un indicateur retardé.

Ces faits stylisés nous permettent d’utiliser un modèle simplifié dans lequel les actions permettent de prévoir les salaires, tandis que les évolutions salariales ne permettent pas de prévoir celles des cours boursiers. Notre modèle stylisé permet un calcul analytique du portefeuille de couverture, le LHP, défini comme la projection du passif sur l’univers des titres négociables, ici sur les actions uniquement. La stratégie de réplication implique une allocation aux
actions qui est une fonction du temps, proche de 100% pour des horizons très longs et chutant progressivement vers 12% pour un horizon de un an, où seule la relation de court terme entre évolution des actions et des salaires est prise en compte (une variation de 1% du cours des actions conduit à une variation de 0,12% des salaires).

En raison de la co-intégration, le passage du temps rend les salaires réplicables. À court terme, les actifs réels sont beaucoup plus volatiles que les salaires, mais à mesure que le temps passe, ils finissent par évoluer en ligne avec les salaires. Par conséquent une politique d’investissement de long terme pourra générer une volatilité annualisée qui diminue au cours du temps.

La volatilité annualisée sera de 1,4% à maturité pour des passifs de 50 ans, mais de 15% sur le court terme.

Une vision à long terme implique des risques à court terme, alors que le manque de vision stratégique implique un risque accru à long terme. Les régulations de court terme génèrent en revanche une forte volatilité de long terme. Une stratégie d’investissement de court terme implique une « part actions » fonction du lien à court terme entre actions et salaires, ignorant les dépendances à long terme, ce qui représente un poids des actions d’environ 12%.

Les salaires étant indexés sur la croissance de l’économie, le passif du fond de pension l’est aussi, si bien qu’une détention d’actions trop faible ne suffit pas à couvrir son passif et ce sont les risques de passifs qui s’accumulent sur le long terme, et que la volatilité annuelle d’un investisseur sans vision stratégique augmente avec le temps. Par ailleurs, il est également possible que le rendement attendu des

Figure 2 : Volatilité annualisée induite par la stratégie de réplication
La stratégie de réplication qui minimise les risques sur un horizon donné (ici, cinquante ans) suppose une détention d’actions comme fonction du temps. La détention d’une forte part en actions pour les besoins de réplication de long terme génère une forte volatilité à court terme en raison de la volatilité du marché des actions.
Les conséquences que nous en tirons pour les réglementations comptables et prudentielles sont les suivantes:

• Nous recommandons fortement que la norme IAS 19 tolère une certaine volatilité dans le ratio de provisionnement pour les passifs indexés sur les salaires. À cet égard, le rapprochement avec FRS 17 serait contre-productif.

• Les réglementations prudentielles basées sur le risque (risk-based regulations), qui exigent un provisionnement supplémentaire fonction de la prise de risque dans la stratégie du fonds de pension, doivent mesurer le risque dans une perspective ALM de long terme et non sur la volatilité à court terme du ratio de provisionnement.

Les conséquences pour les fonds de pension sont les suivantes : comme ils ont besoin d’investir en actifs réels pour produire des passifs réels, ils doivent développer des techniques et des modèles dans des perspectives de long terme. Ils devront également démontrer aux autorités de contrôle leur capacité à maîtriser les risques sur le long terme ; la reconnaissance des bénéfices d’une approche long terme se fera par la création de modèles internes qu’ils devront développer.

Conclusion

Tout d’abord, les normes comptables et les règles prudentielles se durcissent, avec une plus grande attention accordée à la volatilité du surplus, ainsi qu’une tolérance moindre pour les déficits.

Ceci plaide pour une amélioration des stratégies de gestion actif-passif et de l’utilisation de l’état de l’art des techniques de gestion comme la gestion ALM dynamique. Une compréhension des contraintes auxquelles sont soumis investissements soit insuffisant pour couvrir la revalorisation des engagements sur les salaires.
Résumé

Les fonds de pension est essentielle à la construction de stratégies ALM efficaces:
• Le portefeuille qui minimise le risque réglementaire doit tenir compte du taux d’escompte réglementaire.
• Les règles de rééquilibrage des actifs doivent être fonction du surplus ainsi que des intuitions ou techniques de l’ALM dynamique et de l’assurance de portefeuille.
• La modélisation doit saisir les mécanismes de réduction des risques spécifiques au fonds de pension modélisé : indexation conditionnelle, contributions variables, soutien du sponsor, modification de l’allocation d’actifs, soutien du système d’assurance des fonds de pension.
• La pratique de la gestion des risques doit être développée, les différents facteurs de risque auxquels les fonds de pension sont soumis doivent être compris et suivis, et des stratégies efficaces de gestion de ces risques doivent être élaborées.

En outre, une attention particulière devrait être accordée à la nature de long terme des fonds de pension. La réplication des passifs indexés sur les salaires illustre selon nous parfaitement les défis à venir pour les régulateurs comptables et prudentiels ainsi que pour les fonds de pension eux-mêmes. Ces engagements liés aux retraites traditionnelles sont peu réplicables à court-terme, si bien que les stratégies de long terme peu risquées génèrent du risque de court-terme. En conséquence, une focalisation excessive sur le court terme est pénalisante et inquiétante pour les fonds de pension et les systèmes de retraite par capitalisation.

Les passifs qui sont plus facilement réplicables sur le long-terme demandent naturellement des analyses et des pratiques de gestion des risques de long-terme.

L'idée que la gestion des risques est mieux reflétée dans un modèle interne est particulièrement pertinente pour les fonds de pension, puisqu’aucune formule standard ne peut prétendre saisir la diversité des situations et des mécanismes de protection.

Les réglementations les plus modernes permettent l’utilisation de modèles internes pour la définition des exigences de provisionnement, après approbation des autorités de contrôle. Solvabilité II ainsi que la réglementation prudentielle néerlandaise le permettent et ceci est aussi vrai dans une certaine mesure au Royaume-Uni. L’approbation est conditionnée essentiellement par l’utilisation de ces modèles internes dans les domaines suivants: conception des stratégies d’investissement, surveillance des risques et définition de limites de risque, définition de la politique d’indexation, planification des contributions. Lorsque ces conditions sont remplies, les exigences de financement des fonds de pension sont ajustées à la nature de leurs risques – en particulier, les besoins de financement seront réduits lors de l’utilisation par les fonds de pension de techniques de réduction des risques non reconnus par la formule standard (stratégies dynamiques, stratégies d’investissement de long terme).

En un mot, les réglementations comptables et prudentielles menacent de renchérir le coût des retraites de type « prestations définies ». Notre étude conclut que les techniques de gestion actif-passif dynamique et le développement de
modèles internes, entendus comme système de gestion des risques conforme aux exigences réglementaires, permettront de réduire cette menace.
Introduction

Pension funds, which pool assets for the exclusive purpose of financing retirement benefits, are financial giants, with total savings close to $30 trillion, more than 150% of the total capitalisation of the world’s stock markets.

Until the late 1990’s, pension funds invested the bulk of their assets in the stock markets. But the market downturn at the turn of the millennium devastated many pension plans; some companies have been left with pension deficits larger than their stock market capitalisation. In November 2001, the Boots pension fund moved entirely out of equities and into bonds, the first large-scale fund to make such a surprising move. Such developments have called into question the role of equities and real assets in pension fund asset allocation, an issue we look into extensively, in particular in the case of inflation-linked and wage-indexed liabilities, the most common pension liabilities.

Following the market crash, which created pension fund deficits, and the events of September 11, 2001, which worsened the health of the airline industry, United Airlines (UAL) filed for bankruptcy (Chapter 11), a controversial filing that allowed it to cancel its pension obligations and transfer these obligations to the Pension Benefit Guaranty Corporation (PBGC). As pensions benefits are not fully insured by the PBGC, UAL employees lost $3.2bn, a loss that meant anywhere from 20% to more than 50% of their pension rights. Other companies in the US have perhaps filed for bankruptcy simply to shed underfunded pension liabilities, and Chapter 11 is currently being considered by firms such as General Motors. Bankruptcies, especially those whose goal is to shed underfunded pension liabilities, naturally raise the issue of adequate funding requirements. Similarly, financial analysts and accounting standard setters want to ensure improved estimates of the cost of providing pensions and accurate reporting of these costs in sponsors’ financial statements.

The bankruptcy of the sponsors of major pension plans, whose participants often lost not only half their pension rights but also their jobs, and the risk posed by devastated pensions have made transparency and security the latest watchwords. Financial analysts are demanding more transparent accounting, supervisors a better view of the risks involved in running a business, and ministries of labour strengthened security mechanisms.

In accounting, which measures the cost of the pensions as recognised in the sponsor’s accounts, there have been marked changes:

- revisions to IAS 19 in 1998 and 2002 introduced marked-to-market valuations for pension assets and the discounting of pension liabilities at an AA corporate rate
- since 2004, an amendment has allowed immediate recognition of gains and losses in the P&L of the sponsor; in the UK (FRS 17) this immediate recognition has been made mandatory.

Prudential regulations have also experienced tumultuous change; domestic and European regulations have been undergoing constant updating since 2002, funding constraints leave ever less room for manoeuvre, and

1 - Companies that create pension funds are known as sponsors. The sponsor, an employer or association of employers, guarantees the payment of defined benefits.
allowances for pension deficits are being cut down on.

Naturally, the wave of stricter prudential and accounting regulations did not go unnoticed by the providers of services to pension funds and their sponsors. The options now available to pension funds and their sponsors include modern asset-liability management (ALM) techniques as well as new derivative products to supplement ALM techniques and protect pension funds against combined risks such as that of a stock market crash and a fall in interest rates; tentative issues of biometric derivatives have taken place to mitigate non-financial risks such as longevity risk. In addition, ALM techniques may be developed and applied by third parties such as fiduciary management companies; finally, full transfer of risk is made possible in the form of buy-outs, a transaction in which both assets and liabilities are transferred to a third party, often an insurance company, that will assume any further risks and regulatory ramifications.

The wave of closures of defined-benefit pension funds and buy-outs in the UK reveals the attitudes of sponsors toward regulatory changes. Is it that tighter regulatory standards are counterproductive or is it that sponsors are simply making full use of the risk management tools now at their disposal? We review this question both for nominal liabilities and for such real liabilities as inflation- or wage-indexed benefits.

Our study examines the regulatory constraints faced by pension funds and their sponsors and describes the means of responding to these constraints.

Chapter I describes the general context of pension funds and the main indexation policies. We review the mechanisms used by pension plans to ensure that risks are shared by employers and employees, as well as the main indexation features, i.e., how pension rights or pension payments are increased over time. We look at the cultures and structures underlying corporate pension plans (created by individual employers) and multi-employer pension plans (created by industry associations and labour unions).

Chapter II provides a detailed explanation of the accounting and prudential standards under which European pension funds and their sponsors are regulated. Because pension plans are regulated and managed country-wide, we describe the prudential regulations for each country we study: the Netherlands, the UK, Germany, and Switzerland.

Chapter III reviews the modern ALM techniques whose aim is to improve risk management for pension funds. These techniques, which can be called dynamic liability-driven investments, involve dynamic allocation to three blocks: the cash account (the risk-free portfolio for the asset-only investor), the liability-hedging portfolio (the risk-free portfolio for the ALM investor), and the performance-seeking portfolio (the optimal portfolio of risky assets). The allocation to risky assets depends in the main on the surplus and on risk aversion. We look at how these techniques can be used to manage inflation- and wage-indexed liabilities.

Chapter IV examines how pension funds must incorporate regulatory constraints
in the design of their investment strategies.

First, we focus on regulatory prescriptions for the valuation of liabilities or the measure of risk. We look too at the regulatory discount rate, as it governs asset allocation in the event of binding regulatory constraints. For instance, as IAS 19 requires spreading, i.e., discounting liabilities at the yield of AA bonds, fixed liability cash flows require a portfolio of forward credit rate agreements as a match. We then elaborate on the impact of short-term regulatory constraints when replication of liabilities is possible only over the long term—replicating real liabilities requires real assets as a match and the capacity to withstand some short-term market volatility.

If the aim of prudential regulation is to ensure the stability of the retirement system and the continued payment of satisfactory pension benefits, it should seek to avoid short-termism; instead, it should focus on fostering sound risk management practices. These practices, which rely on modern ALM techniques and internal models, will make it possible for pension funds to overcome most of the challenges they face.
1. The General Context of Pension Funds
1. The General Context of Pension Funds

1.1. The “Three-Pillar Structure” of the European Retirement System

The organisation of the retirement system is generally described as a three-pillar structure. This description (see below) is used by both the OECD and the European Union.

• Pillar I, “social security”, involves publicly managed pension schemes with defined benefits and pay-as-you-go (PAYG) financing, usually based on a payroll tax. The two main characteristics of these schemes are that they are organised on a national basis and are generally unfunded PAYG systems.

Public pension plans have traditionally been PAYG-financed. PAYG financing means that pension benefits are financed directly by the contributions of “active” members. A notable exception is the United States, where public pension liabilities are partly PAYG, and partially funded from accumulated contributions.

This pillar is preponderant in the Bismarck countries—Germany, France, Italy, and Belgium. Because PAYG systems are balanced either by adjusting the contribution rates of active members or by revising pensioners’ benefits, ageing populations put the system in jeopardy. The OECD and the World Bank recommend that governments and regulators put in place incentives to encourage the use of second-pillar pension schemes.

In Beveridge countries, where the second pillar is predominant, the first pillar addresses redistribution and social safety net issues directly, and it provides basic support for everyone, usually assistance to provide a standard of living at or above poverty level. In the United Kingdom, this support is a flat-rate percentage of 14% of average national earnings for all workers.

• Pillar II, “occupational pensions”, involves privately managed pension schemes provided as part of an employment contract, and is central to our work.

Occupational pension plans are a three-party organisation that involves the sponsor (an employer), the fund (a manager), and the participants (employees and pensioners), as shown in the box below.

**Box: pension plans**

A pension plan⁵ is a legally binding contract with an explicit retirement objective. These occupational plans may be established by employers or groups thereof (industry associations) and labour or professional associations. The plan may be administered directly by the plan sponsor or by an independent entity (a pension fund or a financial institution acting as pension provider). In the latter case, the plan sponsor may still be responsible for oversight of the operation of the plan.

The plan is administered directly by a private sector employer acting as the plan sponsor, by a private pension fund, or by a private sector provider. In some countries, a pension plan provided by a single employer may be administered by the employer. A pension plan is mandatory when participation in the plan is mandatory for the employer, regardless of whether employee participation and membership are mandatory or voluntary.

Pension plans are voluntary when the establishment of these plans is voluntary for employers.
1. The General Context of Pension Funds

Most common are funded pension plans—plans that accumulate assets specifically to cover plan liabilities. These assets are assigned by law or by contract to the pension plan. Their use is restricted to the payment of pension plan benefits. Book reserved pension plans, which are different from funded pension plans, are almost unique to Germany and will be described in the current study. Here, the balance sheet of the plan sponsor contains reserves or provisions for occupational pension plan benefits; in other words, industrial investments may be financed out of pension liabilities.

- Pillar III, “individual saving schemes”, consists of personal pension plans in the form of individual savings and annuity schemes.

It is generally believed that the role of the third pillar is to encourage individuals and businesses to save, if they wish to, for more generous benefits.

The third pillar rarely involves the participation of pension funds, as employers have no role in these savings. There is usually no sponsor at all.

Saving may be done through insurance companies, it may be fully individual, and it may involve virtually any asset class.

1.2. Pension Funds

The definitions we provide in this section are intended to be consistent with those used by the OECD, which are themselves consistent with the definitions used in the main countries of interest (Netherlands, UK, Germany, Switzerland, US).

The pension fund, which pools the assets bought with the contributions to a pension plan for the exclusive purpose of financing pension plan benefits, is a legal entity independent of the sponsor. The plan members have a legal or beneficial right or some other contractual claim to the assets of the pension fund.

Pension funds may take various legal forms, as in the illustration below:

---

Figure 1.1: Forms taken by pension funds

- **Legal personality**
  - 1. Trust/foundation
  - 2. Corporate entity
  - 3. Dedicated provider
  - 4. Other financial institution

- **No legal personality**

---

6 - In the OECD classification. By contrast, the World Bank defines the third pillar as pension plans with voluntary participation.
Pension funds may be special purpose entities with legal personality, such as a trust, or foundation, or they may be corporate entities. Trusts and foundations are predominant among European pension funds with legal personality. Foundations/associations are common in the Netherlands and Switzerland, and trusts (with similar legal forms) are common in the United Kingdom.

They may be legally separated funds without legal personality managed by a provider (pension fund management company) or other financial institution on behalf of the plan/fund members.

Managing the pension plan—both plan assets and contributions—is the responsibility of a board made up of the sponsor, employee representatives, the financial institution that manages the plan, and an independent advisor (the pension actuary). In the UK, the trustee is legally responsible for management and investment.

The choice of legal structure and organisation is influenced by the type of plan as well as by country culture and regulation.

• In defined contribution pension plans, the commitment of the sponsor is limited to making contributions, and the responsibility for managing pension assets may be left to a managing institution.
• When employees do not contribute to the pension plan, they may not have representatives on the board.

1.4. From Defined Contributions to Defined Benefits: Main Types of Pension Plans

Pension plans must be classified either as defined benefit (DB) or defined contribution (DC) for IAS 19 purposes,

"depending on the economic substance of the plan as derived from its principal terms and conditions. Under defined contribution plans:
(a) the entity's legal or constructive obligation is limited to the amount..."
that it agrees to contribute to the fund. Thus, the amount of the post-employment benefits received by the employee is determined by the amount of contributions paid by an entity (and perhaps also the employee) to a post-employment benefit plan or to an insurance company, together with investment returns arising from the contributions; and
(b) in consequence, actuarial risk (that benefits will be less than expected) and investment risk (that assets invested will be insufficient to meet expected benefits) fall on the employee.
All other post-employment benefit plans are defined benefit plans.6

Beyond this IAS 19 classification, there is in reality a wide range of “hybrid plans”, which are neither entirely DC nor entirely DB in the sense that a fraction of the benefits paid out is in reality linked to the evolution of the financial markets and possibly other risk factors; in other words, there is some risk-sharing.

These plans have generally been set up either to maximise regulatory benefits or to share risks more efficiently. The evolution of regulatory standards has led to an increase in the range of pension schemes available in recent years.

**Individual DC**
Individual DC plans are pure DC plans. Actuarial and investment risks are fully borne by the fund members.

**Collective DC: New Plan Design in the Netherlands**
As the Pension Rights Centre (2007) says, "Up until now, workers in the Netherlands have typically been covered by industry-wide defined benefit plans. These plans are administered by boards which include representatives of employers, workers, and retirees. Together with

---

Figure 1.2: From defined benefits to defined contributions
Tentative classification of pension plans by risk-sharing mechanism. On the upper left side, risk is borne by sponsors. Hybrid plans involve risk-sharing mechanisms. On the bottom right are individual DC schemes, the risks of which are borne entirely by participants.
the Dutch social security benefit, these traditional plans are designed to provide a total replacement rate of 70 percent of preretirement salary. In these plans, both employers and employees contribute, but employers bear the investment risk. If investments perform poorly, employers must contribute more, while if investments perform well, employers can contribute less and may even get refunds.

In the past couple of years, Dutch employers [following the example of Denmark and Iceland] have started adopting a new type of pension plan. This type of plan looks a lot like a traditional defined benefit pension plan, but differs in one key respect — it shifts both investment risk and longevity risk to plan employees and retirees. This plan is called a "collective defined contribution plan".

In a collective defined contribution plan, employees earn benefits based on their salaries each year (a "career average" benefit formula). Workers do not have individual accounts as they would in a defined contribution plan in the United States. Instead, the money is pooled for investment purposes, and employees receive benefits solely in the form of a price-indexed lifetime payments beginning at retirement. These plans are structured to provide similar to that replacement income of traditional defined benefit plans.

Employers and employees contribute a fixed percentage of wages to these plans. The percentage is designed to ensure that the plans are well funded, with a target cushion of 30% overfunding. Employers have no additional liability if the investments of the plans perform poorly, and receive no benefit if the investments perform well. The risks of unexpected investment losses and longer than anticipated life expectancies is entirely borne by the employees and retirees as a group.

If a collective DC plan suffers investment losses and becomes underfunded, the plan’s governing body, which has representatives of employers, employees, and retirees, decides what adjustments should be made. The adjustments can be an increase in contributions by employees (but not employers) or elimination of cost-of-living adjustments, and, in extreme cases, reductions in the benefits earned in future years. If the plan becomes overfunded, the workers, rather than the employer, benefit.

Collective DC plans have advantages for employers and employees. An advantage for employers is that their contributions are fixed and predictable, while under traditional defined benefit plans their contributions may vary. Also, for accounting purposes employers treat the plans as defined contribution plans, and thus do not have to reflect unfunded liabilities, with their intrinsic volatility, on their financial statements. An advantage for employees is that unlike individual DC plans, collective DC plans pool individual risks.

Not well noticed is that agreements on limited contributions from sponsors of DB schemes effectively makes them similar to collective DC schemes, and if the parties come to an agreement
on making fixed contributions the distinction is blurred altogether. After all, when a sponsor's commitment is capped, the cost of significant underfunding is shifted to participants, who will then either receive lower benefits or have to make increased contributions”.

Hybrid schemes as a combination of DC and DB (often final salary plans in the UK)

Hybrid plans combine DB and DC features. In general, they are treated as DB plans for tax, accounting, and regulatory purposes. However, they incorporate elements of DC plans. Mixed DB plans, which have separate DB and DC components that are treated as parts of the same plan, are the simplest hybrids. Often, benefits are expressed in terms of an account balance and contain a lump-sum payment option that the participant can exercise upon termination of employment with the plan’s sponsor.

In the UK's "nursery scheme" plans, workers actually bear the investment risks until they reach a certain age or employment length and then earn benefits similar to those of a last-wage pension plan.

In the "cash balance" plans common in the US, the employee's notional account balance grows by a defined interest rate and with annual employer contributions. These plans offer protection from investment risk (through an interest rate guarantee) but shift all longevity risk to the individual (benefits are usually paid as a lump sum).

Conditional indexation: risk-sharing mechanisms in Dutch DB schemes

These plans, which were first created in the Netherlands, in response to the new funding regulation in the Netherlands, are discussed in greater detail in section 2.2.4.1 Rather than closing pension funds, as in the UK, Dutch pension plans chose to make indexation conditional on the funding ratio of the plan.

Conditional indexation in pension plans is similar to profit sharing in insurance companies: employees of Dutch pension plans see their guaranteed pension increase only when the pension fund posts surpluses above those called for by prudential funding requirements. This mechanism is not unlike that of with-profit insurance policies in which policyholders see their mathematical reserves or final guarantees increase when the insurance company is profitable.

Making indexation conditional on the funding ratio of the pension plan naturally makes it possible for the pension fund to avoid stating that it is insufficiently funded to keep the promises it made, and this move must on the whole be understood as a way to avoid excessive funding requirements. As such, it is similar to the shift from DB to DC in the UK. However, while many sponsors in the UK have stopped providing long-term guarantees to their employees, their Dutch counterparts have chosen to have employees and employers bear risk more equally, and in the alternative case of collective DC, to maintain some risk-sharing mechanisms even if between employees alone (see above).

Unconditional DB with full indexation

These plans are “full DB plans”, as the employees are guaranteed a defined benefit. In the absence of pension insurance schemes, some benefits are forgone if the sponsor goes bankrupt while the pension fund is underfunded.
1.5. Defined Benefit Plans Improve Employee Welfare

The risk-sharing mechanisms described above are a partial answer to tightening regulations. From the point of view of plan participants, these options are always better than pure DC plans, as risk-sharing mechanisms make it possible to smooth individual consumption and lead to welfare gains.

Annuities improve welfare in much the same way as DB plans do:

• Annuities are beneficial to the retired. After all, a life annuity insures an individual against longevity risk or against the risk of running out of savings. Any risk-averse person will demand insurance against that risk. By pooling the risk of mortality/longevity of policyholders of the same generation (for insurance products), and over more than one generation (for pension funds, because of the sharing of risk between active members and pensioners), annuities redistribute from those who live for a relatively short time into retirement to those who live for a relatively long time, and allow increased consumption.

• If the demand for pure annuities is low, that may be (e.g., Yaari 1965) explained as follows: the bond-like returns of pure annuities make them unappealing to younger generations; older people have a desire for transmission, additionally, the price increases for older generations, due in part to the possibility for adverse selection when buying annuities near retirement age.

• However, pension funds offer a mix of annuity and investment returns, and generally a mix of annuity payments and a lump sum that should make the defined benefits particularly attractive, especially when compared to pure DC schemes.

The success of variable annuities in the US, which also combine protection from longevity risk, equity-like expected returns, and tax savings components may well illustrate the need for DB schemes.

Interestingly, it has also been argued in the US (Humphreys 1993) that the rise in DC plans may not serve public policy interests. In DC plans, after all, participants are generally permitted to receive the benefit in the form of a lump-sum distribution at the age of sixty-five; given rising life expectancies, they may need to be supported by social security at an older age.

1.6. Indexing of Defined Benefits (and Hybrid DB)

Most pension benefits are indexed, i.e., pension rights or pension payments are increased over time with an index linked to inflation, wages, financial returns or plan returns. Because a 3% yearly increase in rights leads to an 80% increase in value after twenty years, indexing is a particularly important to employees. For managers, indexing rules are essential to the definition of the investment strategy.

The current section provides an overview of the indexing rules in European pension funds.

In traditional pension plans, such as the last-wage pension plan, benefits are fully defined by a formula, usually linked to employment length, inflation, and wages. The starting pension is linked to the wages earned in the last years, and then, in the most generous plans, to a wage index (either the national wage index or an industry wage index). Wage indexation allows pensioners to maintain their standard of
1. The General Context of Pension Funds

living after retirement, as their earnings move in tandem with those of the working population. Such indexing, however, was usually a practice rather than a regulatory requirement.

Laws whose aims are to protect either contributions or pensions against changes in prices generally require that accumulated savings or pensions be indexed to inflation. The UK requires indexing for active members,7 deferred members, and pensioners, Germany for pensioners only, and Switzerland for active and deferred members only. In the Netherlands, indexation policy must be made explicit but no specific index is required. Indexation in the Netherlands is the responsibility of the pension fund, not the sponsor, and pension assets will be allocated entirely to plan members in the event of sponsor bankruptcy, even if the pension is overfunded.

There has been a broad trend toward de-indexing pensions so as to lower their cost.

Private sector initiatives—offering average-wage rather than last-wage pension plans, reducing either the amount of indexing or, where possible, making it conditional—have contributed greatly to this trend.

In addition, laws have been amended to reduce the cost of providing pensions. In Switzerland, for instance, the accumulated savings8 of active members were legally indexed to an average of national inflation and wages every two years. They now need be indexed to inflation alone. In the UK, both deferred benefits and pensions in payment are legally indexed to inflation, with a cap. To reduce the burden on DB pension schemes, the Pension Act of 2004 provided for the limited price indexation cap to decrease from 5% to 2.5%.

In hybrid DB pension plans, any indexing is a function either of the funding ratio of the pension plan (in the Netherlands) or of financial returns (in German pension plans). We may note that even in traditional benefit plans, high funding ratios have tended to “leak” to benefits, i.e. they result in benefit increases or reductions in contributions in an unplanned manner. Hybrid pension plans establish clear rules for the link between asset returns and benefits.

7 - Active members are current employees, deferred members are past employees who have not reached pension age, and pensioners receive pensions in payment from pension funds.
8 - The amount in the books before conversion into an annuity at retirement age, and with the legal conversion rate at the time of conversion.
# 1. The General Context of Pension Funds

## Table 1.1: Indexing rules for plan benefits: a country summary

<table>
<thead>
<tr>
<th>Country</th>
<th>Legal rule</th>
<th>Fund practices</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>No legal obligation for indexing; however, any indexing must be the same for active members and pensioners.</td>
<td>Funds target long-term indexing to wages, inflation or inflation plus a spread. Indexing is conditional to the funding ratio (unconditional indexing became too expensive in the new Dutch regulatory framework).</td>
<td>Target indexing implies flexibility for management both in the indexing practice and in the construction of the investment portfolio.</td>
</tr>
<tr>
<td>UK</td>
<td>Indexing both of deferred benefits and pensions in payment to min (inflation, 2.5%) by law. Older liabilities with different indexing rules.</td>
<td>Rather traditional DB mode.</td>
<td>Mandatory inflation indexation with a cap involves inflation-linked derivatives as a hedge.</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Accumulated savings (active members) are accrued with inflation every two years (previously mix of inflation and wages).</td>
<td></td>
<td>Mandatory inflation indexation in theory involves inflation-linked securities as a hedge. However, technical provisions are measured excluding mandatory inflation indexation.</td>
</tr>
<tr>
<td>Germany</td>
<td>No mandatory indexation for active members of Pensionsfonds, but indexation of pensions in payment is required. Main option: to inflation “in normal circumstances” Alternative: fixed 1% commitment from beginning.</td>
<td>Active members may benefit from a guaranteed interest rate. Mathematical reserves otherwise increased in a manner similar to profit-sharing in insurance contracts.</td>
<td>Legal indexing rule was meant to be fair but lacked clarity. Judicial procedures were sometimes made in the case of forgone indexing.</td>
</tr>
</tbody>
</table>
2. The Regulatory and Accounting Context
2. The Regulatory and Accounting Context

Prudential and accounting contexts matter where there are rights to be protected. As a consequence, this section will deal primarily with occupational DB pension plans financed through autonomous pension funds. We will focus in particular on the impact of funding requirements on corporate (single-employer) pension funds as well as on multi-employer schemes, which are usually industry-wide schemes. In general, regulation of occupational pension plans and pension funds is the affair of government ministries or departments overseeing labour and social welfare policy and of economic and financial authorities.

Regulations start with incentives given by tax authorities for employers and employees to make tax-deductible contributions to pension funds.

With a view to limiting the ability of employers to delay the payment of taxes on profits by making exaggerated contributions to pension funds, tax authorities have introduced maximum funding limits, above which tax-deductibility is curtailed. These funding limits were of greater importance in the 1990’s, when the strong performance of the stock market created growing surpluses.

The second wave of regulation is prudential and usually comes from ministries of labour, as a reaction to pension plan failures. The objective is to protect the rights of plan members, and the regulations often create minimum funding requirements and mandate prudent investment of the assets of pension plans. Quantitative restrictions are gradually being replaced by the “prudent person” rule throughout Europe, following the European Pension Fund directive—this principle-based rule requires only that investments be both prudent and adequate.

The funding requirements are generally based on the commitments that must be made good on in the event of sponsor bankruptcy. Regulations also require:

- The payment of the current year’s “normal costs” or “current service cost”, the present value of benefits to be earned by active members for one additional year of service (as defined by the actuarial funding method used to calculate funding)
- An amortisation of funding shortfall (fast for “experience deficiencies”—that is, low investment returns, large salary increases, or improvements in life expectancy—but slower for initial unfunded liability existing at the time the legislation was approved or a new pension plan was established).

The stock market crash of early 2000 triggered many reactions, which will be examined in the country analyses. From a regulatory standpoint, improved protection of policyholder rights was enforced either by stricter funding requirements or by the creation of pension fund insurance, which protects the policyholder in the event of sponsor bankruptcy.

The crash also led to the development of stricter accounting standards that encompass the cost of pension benefits as well, because these off-balance sheet items represented considerable amounts for some companies, most of them old. In line with regulatory requirements, funding costs can be divided into “normal
2. The Regulatory and Accounting Context

International accounting standards have adopted a general trend toward market value, even though the concept of market value requires clarification in the context of pension liabilities. The valuation choice made in IAS 19 should be referred to as “going-concern best estimate” rather than “market value”. Market value, after all, is generally defined as the transfer value in the event of the bankruptcy of the guarantee provider, and thus in theory should be understood as taking into account the probability of default of the sponsor. By accounting for future wage increases that would of course not take place in the event of sponsor bankruptcy, IAS 19 departs from the concept of transfer value. Indeed, the main valuation tool now used in accounting is the projected unit credit, which involves the projection and valuation of any expected informal benefit to be paid for, such as future wage increases.

Though prudential requirements have also become stiffer—they now limit the ability to discount liabilities with equity-like expected returns—they do require the valuation not of projected benefits but of accrued benefits.

New insurance industry regulations—Solvency II—have also had a great influence on the philosophy of pension fund regulation in Northern countries; the aim is to build buffers against any risk borne by the pension fund. Though Solvency II itself is not fit for the regulation of pension plans, the more general philosophy that requirements should be risk sensitive is gradually being applied throughout Europe, following the European Pension Fund directive, which defines common standards for European regulations of pension plans/funds. The risk-sensitivity of regulations is ensured either by the use of required buffers (mainly continental Europe) or by collecting levies from the pension fund in the event of underfunding (the UK, insurance schemes).

2.1. Accounting Standards

2.1.1. Review of actuarial methods used for contributions and funding

We will begin with a review of the current unit and projected unit methods, the conventional actuarial accounting methods of valuing pension liabilities.

A consensus has taken shape—although not without debate—around the regulatory and accounting principles for measuring liabilities. It involves:

- Using market value for pension fund assets
- Using market-related discount rate that reflects long-term bond yields (high quality corporate bond yields, typically AA for accounting, a trend toward risk-free yields for prudential regulation)
- Using a straight-line approach for amortisation of gains and losses
- Using an explicit and complete set of actuarial assumptions as opposed to an arbitrary discount rate to take risks into account.

Regulations and accounting standards differ mainly because regulations use accrued benefits to value liabilities, while accounting standards use the projected liability obligation, a going-concern
2. The Regulatory and Accounting Context

best estimate, as opposed to run-off or liquidation approaches.

It should be noted that preceding versions of IAS 19 considered the accrued benefit valuation the benchmark and the projected benefit valuation a possible alternative. Now (in IAS 26), the two methods are allowed only for the pension plan itself.

Equally important is that old accounting standards made it possible to use arbitrary discount rates to take into account unidentified risks.

Methods: the projected benefit obligation (PBO) takes future increases in wages into account, while the accrued benefit obligation (ABO) does not.

The purpose of this section is to provide a brief review of two of the main actuarial funding methods, which can be divided into two main categories: accrued benefit (as in the current unit method) and projected benefit (as in projected unit credit).

Accrued vs. projected benefits.

In both funding methods, benefits are defined as pensions-in-payment, deferred pensions of former employees, and benefits earned by current participating employees (active plan members) as of the actuarial valuation date—only benefits due as a result of contributions already made are taken into account.

The difference is that accrued benefits involve run-off/termination, whereas projected benefits require a going-concern outlook. In other words, accrued benefits do not include the effect of future service, whereas projected benefits do, at least in part. Accrued benefits under a final-average earnings plan would generally be calculated on each employee's current salary; projected benefits, by contrast, are calculated on expected last or average wage. In general, projected benefits take into account any indexing conditional on future years of service as well as on future funding levels of the pension plan, whereas accrued benefits would take into account only formal unconditional indexing, such as the indexing of pension payments to the consumer price index.

The two major corresponding funding methods are the current unit credit and projected unit credit.

Under current unit credit (CUC), accrued liabilities would approximate the value of the benefits the employee would receive upon immediate termination of service or upon plan termination. For this reason, current unit credit has traditionally been used to define the minimum funding requirement—sufficient assets to guarantee the payment of pension liabilities in the event of the sudden bankruptcy of the sponsor (in which case no wage increases are to be expected).

"The basic contribution for the next year is then
(a) the present value of the increase in accrued benefits, primarily the effect of one year's salary increase,

plus

(b) the present value of the benefits to be earned by the active members because of an additional year of service. The rules of the plan would govern the allocation of this contribution between the employees and the employer."
2. The Regulatory and Accounting Context

In **projected unit credit** (PUC), the calculation of liabilities is made on a “projected” basis. The “current service cost” or normal cost is the present value of benefits to be earned by active members for one additional year of service. If the actuarial assumptions made at the preceding valuation date are correct, there is no need to update the calculation of past liabilities as wage increases are already included. The contribution is, however, increased to correct underfunding (or decreased in the event of overfunding or excess returns on assets). The amount of the correction for underfunding is subject to specific rules but is nonetheless the responsibility of the pension board or actuary.

PUC is considered more relevant for planning contributions than for funding. Its calculation is more forward looking, which should make contributions more stable (and more aligned with the growth plans and financial planning of the sponsor).

PUC, used in international accounting standards (IAS 19), initially for a fair estimate of the cost of running a pension scheme, is becoming an implicit reference point for funding.

For greater stability of contributions, **contribution-driven** methods are used. They are **prospective benefit funding methods** and more thoroughly include the effects of future service. The three most important prospective benefit methods are attained age, entry age, and aggregate.

**Attained Age** (AttAge) defines the future normal funding rate as the ratio of (a) the present value of all benefits accruing after the valuation date to (b) the present value of future salaries, divided by (c) the current payroll of the plan members. Current overfunding or underfunding is also adjusted.

**Entry Age** defines the normal cost as the percentage of pay that would exactly fund each member’s prospective benefits (if stable in time). “Prospective benefits” recognise projected future service. Future funding contributions include an adjustment for the difference between accumulated assets and these accrued liabilities.

**Aggregate** (AGG) defines the normal funding rate by subtracting the fund assets from the present value of all prospective benefits and then dividing the result by the present value of future salaries. The resulting funding rate is then applied to the current payroll of the plan members. The effect of projected future service is also included. There is no unfunded liability in this approach, as all experience gains and losses are absorbed into the single calculation. In effect, they are (slowly) amortised through to retirement age.
2. The Regulatory and Accounting Context

Table 2.1: Illustrative calculations of funding methods

The table below, taken from Pugh (2004) illustrates the fundamental differences in the calculations of the funding rates under four of the above actuarial funding methods. The same asset value is used in all cases. This common starting point helps to highlight the effects of moving forward with each of the funding methods. In reality, if each funding method had been used in the past, the contributions to the pension fund—and the resulting accumulation of assets—would have been different.

<table>
<thead>
<tr>
<th>(PV = present value)</th>
<th>Value</th>
<th>CUC</th>
<th>PUC</th>
<th>AttAge</th>
<th>AGG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets in the pension fund</td>
<td>120</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PV of accrued benefits (current salaries)</td>
<td>80</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of benefits accrued one year from now</td>
<td>88</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of one year’s benefits (projected salaries), i.e., (current) service cost under PUC method</td>
<td>11</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of accrued benefits (projected salaries)</td>
<td>150</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>PV of future benefits (projected salaries)</td>
<td>130</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of total projected benefits (150 + 130)</td>
<td>280</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV of future salaries</td>
<td>1,000</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current payroll</td>
<td>110</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

Current Unit Credit:
- **Basic contribution** = 88 – 80 = 8
- But there is a funding excess of 40 (120 assets – 80 liabilities) that can be applied to reduce contributions.

Projected Unit Credit:
- **Basic contribution** = Service Cost = 11 = 10.9% of payroll.
- But there is also a funding shortfall of 30 (150 liabilities – 120 assets) that need to be addressed. For example, by being amortised over the next five years.

Attained Age:
- Future funding rate = 130 divided by 1,000 = 13.0% of payroll, so contribution = 14.3
- But there is also a funding shortfall of 30 (150 liabilities – 120 assets) that need to be addressed. For example, by being amortised over the next five years.

Aggregate:
- Funding rate = (280 total liabilities – 120 assets) ÷ 1,000 = 16.0% of payroll = 17.6

Figure 2.1: Current benefits vs. projected benefits—contributions and reserves

Our sample pension plan provides a lump sum of 10% of final salary for each year of service. The lump sum is payable at the age of 65. We will now focus on an employee who is 45, has worked twenty years in the same company, and whose current annual salary is €50k. If the employee leaves now, or if the company goes bankrupt, he will receive €100k when he is 65. This amount, the DB obligation, is discounted in both methods. For the projection, we assume that the rate of return on plan assets is equal to the discount factor used in both projections (here 4.5%).

In this example, the final liability values converge, whether they are measured as accrued benefits or projected benefits. The accrued liability is much lower at the outset, and so are contributions. Lower funding levels in early years (when CUC is used, fund assets equal the accrued liability, and the projected liability when PUC is used) mean that pension plan assets need to catch up in later years.
2. The Regulatory and Accounting Context

2.1.2. IAS 19—accounting for employers (sponsors)
IAS 19 has been mandatory for all listed companies in Europe since 1 January 2006, for financial periods starting on or after 1 January 2005. Earlier adoption was permitted, and member states had the right to delay the adoption of IFRS and IAS 19 until 2007 for non-EU companies, or EU companies listed outside of Europe and using US or other GAAP.

In addition, European regulation gives EU member states the right to require or permit IFRS for unlisted companies, and to require or permit IFRS in parent company (unconsolidated) financial statements. IAS 19 seems to be the preferred option in Europe—the UK has adopted a similar norm, FRS 17, further detailed in section 2.1.2.3. Switzerland, for its part, is not subject to EU regulations. International companies listed on the Swiss exchange are required to use either IFRS or US GAAP, and, as mentioned in IAS Plus (2008), for domestic companies compliance with IFRS ensures compliance with the Swiss GAAP.
So, in practice, most listed companies conform to IFRS.

At the outset, IAS 19 focused on the cost of retirement benefits, and its 1993 version was named IAS 19 Retirement Benefit Costs. “IAS 19 Employee Benefits” was initially published in February 1998. According to the IASB, the standard shall be applied by an employer in accounting for all employee benefits, except those to which IFRS 2 Share-based Payment applies. Four categories of employee benefits are identified:

- (a) short-term employee benefits, such as wages, salaries, and social security contributions, paid annual leave and paid sick leave, profit-sharing and bonuses (if payable within twelve months of the end of the period) and non-monetary benefits (such as medical care, housing, cars, and free or subsidised goods or services) for current employees;
- (b) post-employment benefits such as pensions, other retirement benefits, post-employment life insurance, and post-employment medical care;
- (c) other long-term employee benefits, including long-service leave or sabbatical leave, jubilee or other long-service benefits, long-term disability benefits and, if they are payable twelve months or more after the end of the period, profit-sharing, bonuses, and deferred compensation; and
- (d) termination benefits" (IAS 19).

Our focus is on post-employment benefit plans in particular.

DC plans
We recall that in DC plans, an entity pays fixed contributions to another entity (a fund) and will have no legal or constructive obligation to pay further contributions if the fund does not hold sufficient assets to pay all employee benefits relating to employee service in the current and prior periods. IAS 19 requires an entity to recognise contributions to a DC plan.
2. The Regulatory and Accounting Context

when an employee has rendered service in exchange for those contributions.

“The reporting entity’s obligation for each period is determined by the amounts to be contributed for that period. Consequently, no actuarial assumptions are required to measure the obligation or the expense and there is no possibility of any actuarial gain or loss. Moreover, the obligations are measured on an undiscounted basis, except where they do not fall due wholly within twelve months after the end of the period in which the employees render the related service” (IAS 19).

IAS 19 requires the use of projected unit credit to value pension liabilities (PBO).

Some of the examples in the current section are directly borrowed from IAS 19.

**DB plans**

All other post-employment benefit plans are DB plans, whether they are unfunded, wholly funded or partly funded. IAS 19 requires an entity to:

“(a) account not only for its legal obligation, but also for any constructive obligation that arises from the entity's practices;
(b) determine the present value of defined benefit obligations and the fair value of any plan assets with sufficient regularity that the amounts recognised in the financial statements do not differ materially from the amounts that would be determined at the balance sheet date;
(c) use the Projected Unit Credit method to measure its obligations and costs;
(d) attribute benefit, separately to current and prior periods of service (...);
Benefits attributable to the current period are used to calculate current service cost.
(e) use unbiased and mutually compatible actuarial assumptions about demographic variables (such as employee turnover and mortality) and financial variables (such as future increases in salaries, changes in medical costs and certain changes in state benefits). Financial assumptions should be based on market expectations, at the balance sheet date, for the period over which the obligations are to be settled;
(f) determine the discount rate by reference to market yields at the balance sheet date on high quality corporate bonds of a (currency and) term consistent with the (currency and) term of the post-employment benefit obligations”;

Note that (e) and (f), new to the revised standard, represent a major shift toward market-consistent valuation of pension liabilities.

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14 - A lump sum is a single payment rather than an annuity.

**Example 1: Projected unit, lump sum**

A DB plan provides a lump-sum benefit of 100 payable on retirement for each year of service. The current service cost is the present value (PV) of 100, and the PV of the DB obligation is the PV of 100, multiplied by the number of years of service up to the balance sheet date. If the benefit is payable when the employee leaves the entity, he will then receive an undiscounted 100 per year of service, higher than the discounted value present in the books.

With an expected maturity of ten years, and a AA corporate bond yield of 5%, the defined benefit is accounted for as $100 \times 0.05^{10} = 61$
Example 2: Projected unit, last wage
A plan provides a monthly pension of 0.5% of final salary for each year of service, payable from the age of 65. The PV of the DB obligation is the PV of monthly pension payments of 0.5% of final salary, multiplied by the number of years of service up to the balance sheet date. The current service cost measures the PV of the benefit attributed over the last year. Both values are discounted because pension payments begin at the age of 65.
Suppose the conversion rate for an annuity is 7.1%, i.e., a value of 100 at 65 is converted into an annuity that pays 7.1 per year until death, equivalent to 0.6 per month. With twenty years of service, the expected monthly retirement amount is 10% of the last wage, equivalent to final accumulated savings of 10%/0.6%=16.66 times the last wage.
The current wage is €2,000 per month, with an expected increase of 5.5% per year. With the discount rate at 5%, and the starting pension date in ten years, the present value of the DB obligation is: 16.66*€2,000*(1.055/1.05)10= €35,000.
This differs from the accrued benefit measure of the liability, which excludes expected wage growth from the calculation, and leads instead to a present value of: 16.66*€2,000/1.0510= €20,465

Example 3: Projected unit credit, complete calculation
A lump-sum benefit is payable on termination of service and is equal to 1% of final salary for each year of service. The salary in year 1 is 10,000 and is assumed to increase at 7% (compounded) each year. The discount rate used is 10% per year.
The following table shows how the obligation builds up for an employee who is expected to leave at the end of year 5, assuming that there are no changes to actuarial assumptions. For simplicity's sake, this example ignores the additional adjustment needed to reflect the probability that the employee may leave at an earlier or later date.

Table 2.2: Calculation of projected benefits

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit attributed to:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>– prior years</td>
<td>0</td>
<td>131</td>
<td>262</td>
<td>393</td>
<td>524</td>
</tr>
<tr>
<td>– current year (1% of final salary)</td>
<td>131</td>
<td>131</td>
<td>131</td>
<td>131</td>
<td>131</td>
</tr>
<tr>
<td>– current and prior years</td>
<td>131</td>
<td>262</td>
<td>393</td>
<td>524</td>
<td>655</td>
</tr>
<tr>
<td>Opening obligation</td>
<td>–</td>
<td>89</td>
<td>196</td>
<td>324</td>
<td>476</td>
</tr>
<tr>
<td>Interest at 10%</td>
<td>–</td>
<td>9</td>
<td>20</td>
<td>33</td>
<td>48</td>
</tr>
<tr>
<td>Current service cost</td>
<td>89</td>
<td>98</td>
<td>108</td>
<td>119</td>
<td>131</td>
</tr>
<tr>
<td>Closing obligation</td>
<td>89</td>
<td>196</td>
<td>324</td>
<td>476</td>
<td>655</td>
</tr>
</tbody>
</table>

Note:
1. The opening obligation is the present value of benefits attributed to prior years.
2. The current service cost is the present value of benefits attributed to the current year.
3. The closing obligation is the present value of benefits attributed to current and prior years.
2. The Regulatory and Accounting Context

Balance Sheet
The amount recognised as a DB liability shall be the net total of the present value of the DB obligation at the balance sheet date minus the fair value at the balance sheet date of plan assets (if any) out of which the obligations are to be settled directly. Correction is made upwards for any actuarial gains (less any actuarial losses), minus any past service cost not yet recognised; as will be detailed below, recognition of actuarial gains and service cost is mandatory when 10% of the value of the plans (assets or liabilities) is breached.

IAAS 19 makes possible the smoothing of gains and losses from (DB) pension plans

Profit or loss
An entity (a sponsor) shall recognise the net total of the following amounts in profit or loss:

(a) current service cost (cost of one year of service under PUC);
(b) interest cost (discount rate times the net opening obligation);
(c) the expected return on any plan assets;
(d) actuarial gains and losses (including the difference between actual return and expected return on plan asset);
(e) other elements, such as past service cost (resulting from the change in the definition of the liability or the introduction of new benefits), the full effect of any curtailments or settlements (reduction in liability), as well as other technical corrections when not measured elsewhere).

Beyond the cost elements mentioned above, the so-called corridor approach is used by default:15 entities recognise the portion of the net cumulative actuarial gains and losses that exceed the greater of 10% of the present value of the defined benefit obligation (before deducting plan assets) and 10% of the fair value of any plan assets.

Central to the calculation of P&L is the difference between actual returns and expected returns on plan assets. In this respect, the actual return on plan assets is the change in fair value of plan assets (after correcting for in and outflows), and the IFRS 39 classification of financial assets does not matter for this calculation (a rise in the value of shares classified AFSEQ figures in the calculation of actual returns on plan assets).

"The portion of actuarial gains and losses to be recognised for each DB plan is the excess that falls outside the 10% "corridor" at the previous reporting date, divided by the expected average remaining working lives of the employees participating in that plan" (IAS 19).
2. The Regulatory and Accounting Context

Example 5: Corridor approach, pass-through of actual investment returns to the P&L of the sponsor

On 1 January 2007, the fair value of plan assets was 10,000 and net cumulative unrecognised actuarial gains were 760. On 30 June 2007, the plan paid benefits of 1,900 and received contributions of 4,900. On 31 December 2007, the fair value of plan assets was 15,000 and the present value of the defined benefit obligation was 14,792. The expected remaining working life of employees is 12.5 years.

On 1 January 2007, the reporting entity made the following estimates, based on market prices on that date:

Table 2.3: Calculation of actuarial gains and impact on sponsor’s P&L

<table>
<thead>
<tr>
<th>Interest and dividend income, after tax payable by the fund</th>
<th>9.25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Realised and unrealised gains on plan assets [after tax]</td>
<td>2.0%</td>
</tr>
<tr>
<td>Administration costs</td>
<td>-1.0%</td>
</tr>
<tr>
<td>Expected rate of return</td>
<td>10.25%</td>
</tr>
</tbody>
</table>

For 2007, the expected and actual return on plan assets are as follows:

| Return on 10,000 held for 12 months at 10.25% | 1025 |
| Return on 3,000 held for six months at 5% (equivalent to 10.25% annually, compounded every six months) | 150 |
| Expected return on plan assets for 2007       | 1175 |
| Fair value of plan assets at 31 December 2007 | 15000 |
| Less fair value of plan assets at 1 January 2007 | -10000 |
| Less contributions received                   | -4900 |
| Add benefits paid                             | 1900 |
| Actual return on plan assets                  | 2000 |
| Difference between actual and expected returns | 825 |
| (previously) unrecognised actuarial gains actuarial loss | 700 |
| Actuarial gains and losses                    | 1525 |
| Corridor limit 10% * max(Value Assets, Value Liabilities) | 1500 |
| Actuarial gain to be discounted               | 25 |
| Expected remaining working life, years        | 12.5 |
| Actuarial gains reported in the P&L of the sponsor: | 2.0 |

The difference between the expected return on plan assets (1,175) and the actual return on plan assets (2,000) is an actuarial gain of 825. Therefore, the cumulative net unrecognised actuarial gains are 1,525 (760 plus 825 less 60). The limits of the corridor are set at 1,500 (the greater of 10% of 15,000 and 10% of 14,792). In the following year (2008), the entity recognises in the income statement an actuarial gain of 25 (1,525 less 1,500) divided by the expected average remaining working life of the employees concerned. The expected return on plan assets for 2008 will be based on market expectations on 01/01/2008 for returns over the entire life of the obligation (source: IAS 19)

It is worth noting that the standard permits systematic methods of faster recognition, such as full immediate recognition of actuarial gains and losses, provided that the same criteria are applied to both gains and losses and consistently from period to period.
2. The Regulatory and Accounting Context

Criticism and areas for clarification

The smoothing features of IAS 19 are sometimes interpreted as an incentive to hide risk in the pension funds.

The smoothing allowed by IAS 19 may be an incentive to use the pension fund balance sheet to hide high-risk exposures. After all, pension fund losses may be quite high before they cross the so-called threshold of materiality and must be reported in the balance sheet of the sponsor: a pension fund with a liability or asset value of €10 billion and a surplus or deficit of less than €1bn need report neither profit nor loss in its accounts. Moreover, when an average remaining working life of twenty years is assumed, any gain above the €1bn threshold impacts the annual P&L of the sponsor by a twentieth of its value, so a market gain of €2bn has a €50m annual impact on the P&L of the sponsor, and a market gain of €3bn has a €100m annual impact (for twenty years).

For this reason, one of the amendments proposed (by the IASB in March 2008) is, as in the UK, to require immediate recognition of pension fund surpluses and deficits. An alternative proposal (CEBS 2008), made to ensure that DB plans do not cause excessive volatility in a sponsor’s P&L, is to report all profit and losses outside the P&L.

Intermediate proposals that involve accounting for part of the changes in equity (in the balance sheet as other comprehensive income) and part in the P&L are also being envisaged.

A more modern terminology and proposed refinements to account for hybrid plans

For conventional plans the DB/DC classification works perfectly well. The classification of and accounting for hybrid plans has, however, led to debate. The IASB has proposed doing away with the DC classification in favour of “contribution-based” plans that encompass previous DC plans as well as such hybrids as cash-balance plans and some career-average plans. The proposals involve technical issues and are still being studied; they are beyond the scope of this paper.

2.1.2.1. Multi-employer exception to IAS 19

Some sponsors of multi-employer DB plans are exempt from IAS 19 rules: when information to consolidate the participation of the sponsor in the plan is unavailable, the pension fund can be re-classified as a DC plan. In this case, rather than accounting for its share of the DB obligation, it treats it as an expense only its contributions to the plan, in much the same way as sponsors of DC plans treat theirs.

This exemption usually applies in two circumstances:
- When the pension plan’s accounting methods are not aligned with IAS 19—recall that IAS 26 allows pension plans to use CUC internally, and a similar method is required for regulatory purposes in the Netherlands. Sponsors then have no access to the IAS 19 numbers they could use in their own statements.
- And, more broadly, when the multiple sponsors of a pension plan pool actuarial
2. The Regulatory and Accounting Context

risks it is impossible to allocate the assets and risks to individual sponsors, as some employees may have worked for more than one plan sponsor.

IAS 26 also allows fixed term, fixed redemption securities to be valued at amortised cost.

2.1.2.2. IAS 26—accounting for pension plans (independently of their sponsors)
The financial statements of retirement benefit plans, where such statements are prepared, and whether the plans are DB or DC shall be prepared to standard 26. This standard is relevant largely when pension funds have a legal personality, independent of that of the sponsor, and must publish accounts.

IAS 26 is generally considered far less important than IAS 19, because in most cases pension funds are non-profit organisations, so any measure of their P&L is largely irrelevant. It is also an older standard, less restrictive than IAS 19, and authorises measuring liabilities on either an accrued or a projected basis. Interestingly, the IASB discusses the pros and cons of each method: it views measuring them on an accrued basis as making for more objective calculations but acknowledges that projecting salaries is useful to the funding policy of pension plans for last-wage plans, because the benefits of active participants are tied largely to projected rather than to current wages.

The case of insured benefits
If an entity outsources the DB obligation to an insurance company, that is, to an outside provider of guarantees, it shall treat the plan as a DC plan (unless the entity retains legal or constructive obligations, such as paying further amounts if the insurer does not pay all future employee benefits).

If insurance arrangements are made for only part of the assets and payoffs of the plan, qualifying insurance policies are accounted for as plan assets (IAS 19).

In the main, it is prescriptive with respect to the content of the reports, to changes in asset and liability value, and to the descriptions of the funding policy and of the methods and assumptions used in the valuation of DB plans.

2.1.2.3. FRS 17—the UK-equivalent of the European IAS 19, yet more restrictive
As IAS 19 is in force throughout Europe, we will comment briefly on two alternative standards in the countries that are of interest to us. The British and American accounting standards, known as FRS 17 and SFAS 87 respectively, are broadly similar to IAS 19 for valuation purposes but much more restrictive for P&L measurement, as both standards require immediate recognition of actuarial gains and losses.

Multi-employer schemes in the UK also benefit from the same IAS 19 “exemption” that is often used in Dutch schemes. The UK standard, FRS 17, is aligned with IAS 19 in this respect. It specifies that if the employers are unable to identify their share of the underlying assets and liabilities of the scheme on a consistent and reasonable basis, they
2. The Regulatory and Accounting Context

should account for the scheme as if it were a DC scheme (i.e., the cost charged to the accounts is simply the total contributions paid in the year, and there is no recognition in the balance sheet of a share of the surplus or deficit). On the other hand, if a scheme is “sectionalised” (which would effectively involve the actuary’s carrying out a separate valuation for each employer in the scheme), the exemption does not apply.

2.1.3. Incentives to the externalisation of pension liabilities
How pension funds can help optimise the balance sheet of the sponsor could be dealt with extensively. The goal here is simply to illustrate that most jurisdictions offer tax and accounting incentives to participate in a pension fund as opposed to keeping pension assets and liabilities on balance sheet.

We also include a brief discussion of the impact of outsourcing pension fund management. This section will include salient examples rather than a comprehensive analysis.

2.1.3.1. Accounting incentives: the IAS 19 smoothing feature and the multi-employer exception
Listed companies must consolidate their pension assets and liabilities in their reporting; hence, the management of these assets and liabilities has a direct impact on financial communication.

Figure 2.2: Accounting decision tree.
Summarises both the advantages and disadvantages of the set ups of defined benefit plans.
2. The Regulatory and Accounting Context

The first (top) leaf of the decision tree (internalise + set aside financial assets = have on-balance sheet financial assets for pension fund liabilities) shows that there are no incentives to manage pension assets on the balance sheet of a European sponsor, at least when it is listed and its financial communication matters. If it did, the sponsor would bear the full volatility of the pension assets and liabilities in its balance sheet, and, as will be shown in the next sub-section, forgo the tax benefits associated with outsourcing.

The second leaf illustrates the German historical policy of allowing investment assets in the balance sheet of the sponsor to back pension liabilities. For unlisted corporate firms that lack access to financial markets, this policy has meant cheap and ample funding capacity. Some conclude that it was the conjunction of a social contract (additional retirement benefits promised by employers) and of the self-financing capacity (resulting from the absence of pension funds) that was responsible for the German economic miracle.

Pension funds (lower branch) may be either corporate (special-purpose pension funds in leaf 3) or multi-employer (leaf 4). For the sponsor, the main advantage of single-employer pension funds is that they make it possible to optimise the smoothing features of IAS 19. As a matter of fact, any deficit is generally amortised over a period of between five and fifteen years. As illustrated in the IAS 19 sub-section (the corridor approach), large gains and losses pass through only very gradually.

The main disadvantage of the single-sponsor scheme, however, is that any underfunding of the pension fund by IAS 19 standards appears as a net debt in the balance sheet of the sponsor. For wage-indexed DB pension plans, IAS 19 may overestimate current liability, and, as a consequence, sponsors may prefer to avoid having to publish accounts that in their belief are a poor reflection of their assets and liabilities. Moreover, news of the underfunding of pension funds has often been ill received and amplified downturns in the stock prices of the sponsor (GM is a memorable example). As a consequence, sponsors of such traditional DB schemes may prefer multi-employer schemes, which make it possible to avoid reporting under IAS 19.

2.1.3.2. Tax incentives (for employers) to externalisation

Tax authorities have historically played the dominant role in the pension fund regulatory environment. They created the conditions under which employees and employers could make contributions—often tax deductible—to a plan, and indeed they still do.

In the UK, the Netherlands, and Switzerland, pension contributions by employers are tax deductible. In the UK, public or semi-public employers are eligible for further tax relief on member contributions and on certain types of investment returns provided assets are ring-fenced.

By contrast, in Germany, where private pensions make up 10% of the total paid pensions, most businesses have chosen not to assign financial assets to their pension liabilities. Historically, liabilities have been reported as an on-balance sheet debt, in other words, similar to any other source of funding for corporate assets. After all, the tax treatment is neutral, as on-balance-
sheet pension liabilities are recognised as a cost by the tax authorities, just as when externalised.

2.2. Prudential Regulations
Regulators generally require that one set of assumptions be used to value liabilities, and accounting standards require another. In short, the philosophy of the prudential regulator differs markedly from that of the accountant.

The aim of accounting is to provide a snapshot—initially focused on the P&L—of the situation of a corporation. IAS 19 may be relevant to an assessment of costs, but not to valuation, because it is inconsistent with other accounting valuation standards for balance sheets. It is inconsistent because the general run-off—or liquidation—hypothesis used in other accounting standards is not used in IAS 19.

Regulators do much more than take simple snapshots. The long-term stability of the private retirement system is in their hands. They must impose prudence and at the same time leave pension providers the flexibility to keep offering good pensions at reasonable costs.

Regulators generally base funding requirements on accrued benefits (which are a measure of minimum benefits) rather than on projected benefits (which are the expected value of benefits). Historically, these benefits were discounted at an equity-like rate of return, a choice that has been widely debated by financial economists and actuaries for both valuation and setting aside reserves ("reserving"), and that we too will revisit.

Prudential regulations in Europe, however, have been tied closely to national social welfare laws. Though pension fund regulation bases all funding requirements on accrued benefits, the valuation assumptions are different, not least with respect to discount rates.

Additional security mechanisms may differ as well; for instance, there may be pension insurance schemes that make funding requirements superfluous.

Hence, prudential regulation of pension funds cannot be analysed without a closer look at the laws and security mechanisms in the host country. Because these mechanisms are diverse, regulations are diverse too, and have remained so two years after the implementation of the so-called IORP directive.

Because Solvency II (SII) has harmonised solvency regulations for insurance companies, and partly because insurance companies are also providers of retirement benefits, there were calls for SII to apply to pensions funds.

However, SII’s standard formula for capital requirements is unfit for this purpose because it ignores the role of the sponsor and the distant investment horizons of pension funds.

Among the improvements in the Solvency II framework are incentives to build internal models. These incentives are gradually being adopted by new domestic regulation, as in the Netherlands and the UK. Because of the variety of both the pension landscape and the security mechanisms, it is more important for pension funds than for any other sector to develop internal models and

18 – See Moriarty (2006) for a discussion of these issues.
set funding requirements according to the risk as measured in these models.

2.2.1. EU prudential regulations are bound by the IORP directive
The framework for European regulations is the so-called 2003 IORP directive, also known as European Directive 2003/41/EC on the activities and supervision of institutions for occupational retirement provision. The IORP directive was to be implemented by September 2005; all European countries achieved implementation by 2007.

The first objective is “to establish rigorous prudential standards ensuring that pension fund members and beneficiaries are properly protected”. This proper protection is achieved mainly by defining minimum funding requirements based on a measure that is at least the accrued benefit obligation. For limited periods of time, however, pension funds may be underfunded—as long as they have a recovery plan.

Another objective of the directive is to provide a means for multinationals to combine their various pension schemes so that they can be operated by one fund with a cross-border status, resulting in cost savings. A pension scheme may be considered cross-border when the sponsor is located in the home country but its members live and work in another EU state. At the moment, there are international pools of assets, but plans are typically held on a national basis for evident tax reasons.

The IORP directive applies to occupational DB pension schemes, including book-reserve schemes, not to first-pillar schemes.

The IORP directive requires that the accrued benefit obligation (ABO) be funded in pension plans or that a recovery plan be made.

For technical provisions, article 15 sets ABO as the minimum standard in qualitative terms, requiring that the minimum amount of technical provisions be sufficient to reflect members’ accrued pension rights, as well as the biometric risks and financial guarantees.

As illustrated in section 2.1.1, accrued benefits reflect the commitments to be honoured in the event of bankruptcy; logically, they are the foundation of prudential funding requirements.

Article 16 requires full funding (sufficient assets to cover the technical provisions) except for a limited period of time. This exception allows both Dutch and British regulation to comply with the European directive, though these two bodies of regulation are of opposing natures and are informed by differing philosophies. Underfunding requires a “concrete and realisable” recovery plan that “shall be made available to members, [ . . . ] their representatives and/or shall be subject to approval by the competent authorities of the home Member State”.

Interestingly, “in drawing up the plan, account shall be taken of the specific situation of the institution, in particular the asset/liability structure, risk profile, liquidity plan, the age profile of the members entitled to receive retirement benefits, start-up schemes and schemes changing from non-funding or partial funding to full funding”.

19 - All quotes in the current section are from the directive.
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Promises made by pension funds
In general, pension funds are distinct from insurance companies in the sense that promises are the responsibility of the plan, and mainly of the sponsors. However, in some hybrid DB schemes (multi-employer schemes in Denmark, and in some cases in the Netherlands), the responsibility of the employer is limited to fixed or nearly fixed contributions; employees bear the risk.

In this case, it can be argued that it is the pension fund that takes the risk, not the sponsor, and in order to better protect employees, article 17 of the IORP directive then requires “additional assets above the technical provisions to serve as a buffer”. In Northern Europe, buffers are indeed being required.

Even when it is the pension fund that makes promises, the sponsor usually has additional commitments to the pension fund and is in effect the first line of defence in the event of deficits.

The IORP directive makes the “prudent person” rule, not quantitative restrictions, the underlying principle of capital investment
Pension funds are specifically recognised as “very long-term investors” by the directive, and as such are differentiated from insurance companies.

Article 18 requires the use of the “prudent person” rule as opposed to quantitative restrictions. In this rather modern approach to investing, “assets shall be invested in the best interests of members and beneficiaries. In the case of a potential conflict of interest, the institution, or the entity which manages its portfolio, shall ensure that the investment is made in the sole interest of members and beneficiaries”; though more detailed quantitative restrictions may be designed at the national level, Member States shall not prevent institutions from investing up to “70% of the assets covering the technical provisions of DB schemes in shares or other negotiable risky securities”, and up to 30% of assets in foreign currencies.

Paragraph 6 of article 18 allows member states to make quantitative restrictions fund-specific (in case of a weak fund or sponsor, or of very specific liabilities).

2.2.2. Diverging applications of the IORP directive
The IORP is a framework directive that defines the main principles of regulation but does not prescribe any particular measure. It is partly for this reason that this directive has permitted multiple interpretations, as summarised in the table below.

Table 2.4: Summary of prudential regulations\textsuperscript{20}
Illustrates the diverging applications of the IORP directive in the definition of the accrued liability, in the discount rate, in the definition of the minimum funding ratio and in the required length of recovery plans.

<table>
<thead>
<tr>
<th>Country</th>
<th>Valuation basis for liabilities</th>
<th>Discount rate</th>
<th>Minimum funding ratio (FR)</th>
<th>Contributions, cost, recovery plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>IORP framework directive</td>
<td>Accrued liability</td>
<td>“Prudent rate”</td>
<td>Full funding except for a limited period of time</td>
<td>“Realistic recovery plan” required</td>
</tr>
<tr>
<td>Netherlands, minimum</td>
<td>Accrued (conditional indexation not valued)</td>
<td>Swap yield curve</td>
<td>Min: 105%</td>
<td>105% restored over 3 years. Cost approximated as ( \frac{MV(A) - 1.05 \cdot PV(L)}{3} )</td>
</tr>
</tbody>
</table>

\textsuperscript{20} - Assets are taken as marked to market in all regulations.
2. The Regulatory and Accounting Context

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Liability Measure</th>
<th>Risk Measure</th>
<th>Funding Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands, target</td>
<td>Accrued</td>
<td>Swap</td>
<td>97.5% VaR ($= 130%) restored over fifteen years.</td>
</tr>
<tr>
<td>The UK, protected liability (SF179)</td>
<td>90% of accrued liability with pre-97 indexation rights forgone</td>
<td>Government bond yield</td>
<td>Levy/contribution to the pension protection fund (PPF) linked to underfunding relative to SF179 liability.</td>
</tr>
<tr>
<td>The UK, statutory funding objective (SFO)</td>
<td>Accrued liability (note that legal inflation indexation valued)</td>
<td>Prudent rate of return, may assume a small equity return premium, but excepted to be lower than 6%</td>
<td>Depending on funding policy, &quot;Restore as quickly as can afford&quot; but average recovery plans 7.5 years. $MV(A) - SFO \over 7.5$</td>
</tr>
<tr>
<td>Germany (Pensionsfonds)</td>
<td>Accrued liability</td>
<td>2.25% (60% of 10 year average LT government bond yield)</td>
<td>100%, with temporary 9% underfunding allowed. Temporary =&gt; short recovery period expected</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Accrued liability, without accounting for mandatory indexation</td>
<td>Prudent estimate of expected return on plan assets</td>
<td>Temporary underfunding allowed. Fund-dependent (no statistics)</td>
</tr>
</tbody>
</table>

Diverging applications of the accrued benefits concept

As we have seen, regulators currently tend to base their minimum funding requirements on the accrued benefits measure of liabilities (ABO using the CUC method) rather than on the projected measure (PBO using the PUC).

Some regulators, however, may be tempted by convergence with other standards, such as IAS accounting standards or SI prudential rules. The projected measure of benefits, for instance, is a point of reference in UK prudential regulation (though not in itself a funding requirement).

In practice, requirements with regards to the recognition of longevity risk also differ; there may be either various degrees of prudence in official mortality tables or additional buffers. In addition, measures of guaranteed indexation may vary. The most salient example is Switzerland, where mandatory revaluation of savings with inflation is not taken into account in valuation (while unconditional indexation in theory is part of the accrued benefit measure).

Discount rate: a trend toward market interest rates

Changes in discount rates can have a major impact on the valuation of long-term liabilities. For post-retirement benefits to be paid between twenty and forty-five years from now, a 1% change in the discount rate means a 30% change in the reported liability value.

The impact of these rate changes on pension fund ALM and on the replicating portfolio is described in section 4.1.1.

The following discount rates are or were common in Europe:

- Fixed discount rate, with the historic 4% discount rate in the Netherlands;
2. The Regulatory and Accounting Context

- Prudent, below risk-free discount rate, such as the 2.25% rate for German liabilities that results from the German interpretation of the third life insurance directive; 2.25% is 60% of the ten-year average of the long-term bond yield.
- The risk-free rate, in practice either the government or swap yield curve, is the new regulatory trend, as exemplified in the new Dutch regulatory framework, the FTK. The UK also uses the risk-free rate to discount the minimum liability (SF179, the lower bound of technical provisions), and implicitly the corporate bond yield because IAS 19 is another reference point for the technical provisions.
- Discount rates that assume an equity risk premium. These rates are still used in the UK and in Switzerland. They are traditional means of authorising or even encouraging a degree of risk-taking: investing pension assets in equities leads to a higher expected return than does investing the assets in bonds, and subsequently to lower pension liabilities.

The debate between proponents of these methods is still lively. While those in favour of discounting at a rate that assumes an equity premium argue that over the long term stocks yield more than bonds and that stock holdings should be encouraged, their opponents point out that lowering pension liabilities as a result of investing pension assets in equities implies, contrary to the principles of (modern) financial economics, and altogether unacceptably, that €1 of equities is worth more than €1 of bonds.

Although pension liabilities are usually not bond-like and require real assets to match indexation, we also argue in section 4.1.1.5 that discounting at an equity risk premium can lead to pro-cyclicality.

As a consequence, discounting at an equity risk premium must be understood as a rudimentary means of allowing pension funds to take risks. In the development of best practice prudential regulations, risk taking should be allowed as long as it is supported by ALM models, the development of which should be encouraged when funding requirements are set.

The two classic regulatory tools to secure pension benefits are stricter funding constraints and insurance guarantee funds for pensions

Collective protection vs. strict sponsoring constraints: stricter funding constraints are mainstream in continental Europe but are not immediately applicable to countries with largely underfunded pension plans.

There are two distinct philosophies when it comes to securing pension benefits.

The first, typical of Northern countries, is to apply strict funding requirements, in essence requesting that pension funds have at all times sufficient assets to cover the accrued liabilities, plus a risk margin. This is the case for the Netherlands, where in the absence of a pension guarantee fund benefits are secured by funding requirements and, in some industry-wide funds, by the solidarity of other participants in the pension plan. The other, common in the UK and in other countries that, either because of their philosophy or because they have no choice but to tolerate underfunded schemes, was to set up a pension benefit guarantee scheme—insurance for pension funds. In exchange for the protection extended to employees in the event of sponsor bankruptcy, the UK pension protection fund collects a “risk-based” levy from underfunded pension funds; the amount of this levy is based
2. The Regulatory and Accounting Context

on the degree of underfunding and on the probability of default of the sponsor. Though not risk-based, Switzerland currently favours the pension insurance scheme over strict funding requirements.

In Germany, uniquely, the two security mechanisms co-exist. Technical provisions include a risk margin, as guarantees are discounted below the risk-free rate, and the PSVaG (Pensions-Sicherungs-Verein Versicherungsverein auf Gegenseitigkeit) is a pension insurance scheme. This redundancy arises because the PSVaG was originally meant to protect employee benefits in book-reserved pension plans.

As long as the levy collected by the pension protection scheme is risk-based, funding requirements and insurance schemes are essentially equivalent, as underfunding is penalised (either by paying a levy to the pension insurance scheme or by borrowing capital to meet strict funding requirements) in both. However, pension insurance is more flexible, not only because it allows the regulator to fine-tune the cost of underfunding, but also because it keeps pension funds, employees, and their sponsors from having to make sudden increases in contributions or to seek funding in the event of underfunding.

In practice, if prudential regulations or the mortality table change, it is very difficult to require by law immediate corrections of underfunding. Enforcement of stricter requirements can also have unwanted consequences. Sponsors may be tempted not only to stop providing DB schemes altogether, but additional requirements of the sponsor may also worsen its situation—what with the negative communication to the financial markets—and increase the risk of bankruptcy, perhaps the worst possible outcome for the employees.

There are also drawbacks to pension insurance, such as adverse selection when the levy paid to the pension insurance scheme is not a reflection of the real risk borne by this scheme, i.e., the combined risk of default of the sponsor and of underfunding in the pension fund is not taken into account. In this respect, the funding scheme set up in the UK has made great improvements to previous insurance schemes.

Although flexibility is necessary, so are funding rules: overly lax funding rules, including the large contribution holidays taken by US and UK sponsors in the 1990’s contributed to the pension debacles of the early 21st century, as catching up proves difficult when markets turn down and sponsors’ own finances worsen.

Diverging recovery periods in European countries
Recovery periods as required by the regulator differ widely from one country to another. Naturally, at one end of the spectrum are countries with full sponsor commitment and pension insurance schemes, and at the other are countries with lower sponsor commitment and no pension insurance scheme.

In the countries of interest, statistics are provided by only two countries, the Netherlands and the UK.

In the Netherlands, where regulation is aligned with both SII and the IORP directive, any breach of the minimum 105% funding requirement must be repaired within three

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21 - On these so-called "holidays" sponsors and employees stop making contributions to the pension fund after it has enjoyed positive returns.
years (contributions are increased and indexation reduced).

By contrast, in the UK, the statutory funding objective (SFO) is linked to technical provisions as defined in the plan. In the event of underfunding—and 70% of British pension funds are underfunded—the recovery plan must be “appropriate” to the health of the sponsor. Although the law does not spell out the maximum recovery period, any period longer than ten years triggers further regulatory inspection of the plan. The average is 7.5 years.

In Germany, it is expected that the authorised recovery time in the event of underfunding will be limited, i.e., closer to the Dutch three-year period than to the English fund-specific one.

Conclusion on the IORP Directive

For the moment, pension funds are the only entities regulated Europe-wide by a framework directive. The use of a framework directive may be seen as recognition of the variety of the pension landscape.

The principles in the framework directive are relatively modern (use of the prudent man rule, not of quantitative restrictions), and their flexibility (underfunding is allowed for a limited period of time) is a natural requirement of the possibility to draw on the sponsor’s guarantee or on additional contributions to cover limited underfunding.

For some reason, the role of additional security mechanisms such as pension insurance is not taken into account in the directive. From a theoretical standpoint, when as in the UK the levy paid to the pension insurance scheme is related to the combined risk of sponsor bankruptcy and underfunding, requiring full funding or payment of levies to the pension insurance scheme is, as it were, six of one or half a dozen of the other.

Though it has arguably failed to favour the development of cross-border pension schemes, the IORP directive has led to greater cooperation among supervisors as they revise domestic regulation.

2.2.3. Solvency II’s standard formula is unfit for pension funds

As we can see, domestic prudential regulations are very diverse. One of the consequences is that the directive is perceived as a first step but not necessarily sufficient to allow the effective creation of cross-border pension plans; so revisions are being discussed.

One of the main outside references is the upcoming prudential regulation for insurance companies, Solvency II (SII). Even before implementation, SII is an essential benchmark for any regulatory body, in particular because it is the most risk-based of all regulatory frameworks. As such, it has had a great influence on regulatory culture, as well as on practices in the insurance or guarantee-provision industries. It has, for instance, contributed to a clearer view of the risks, both underwriting and financial, involved in running a business, to the sharing of best practices among regulators, and to an understanding of these risks. Because of the success in the insurance industry as a whole, and probably because both insurance companies and pension funds may contribute to long-term retirement savings, it is tempting to leverage the progress made during the SII project by applying the lessons learned and, in the
hopes of swifter convergence, to apply SII directly.

In the current section, we will first review the SII framework and then argue that, because of their long-term nature and because of the specific role of the sponsors and future contributions from current and future employees, features not recognised by SII, pension funds cannot be likened to insurance companies.

Pension funds naturally deserve a prudential standard suited to their role and nature. Some of the lessons learned in the SII process may of course be applied with success to pension funds; indeed, some European countries have already done so. An important feature in the SII framework is the possibility to set capital requirements according to the risk as measured in internal models. The development of these models, which lead to better risk management, also ends up leading to lower funding requirements.

2.2.3.1. SII is the only true risk-based prudential regulation
SII is the new European prudential regulation for insurance companies.
• SII aligns capital requirements with economic capital.
SII is to insurers what Basel II is to banks, with solvency capital requirements made risk sensitive. However, whereas Basel II does not allow accounting for diversification of risk types, SII does. SII also relies more on principles than does Basel II, so, on the whole, solvency capital requirements can be thought of as a proxy for economic capital for the insurance industry. This likening of regulatory capital requirements and economic capital is a desirable regulatory feature, because it aligns regulations with best practices in risk management, all the more so as SII allows the use of internal models for the calculation of capital requirements.
• SII is a full fair value standard.
SII is the first regulation to adopt a full fair value approach. Unlike earlier prudential standards, including IFRS, it values all assets at marked to market (or marked to model when market value is not observable), making no exception for amortised cost items (such as held-to-maturity bonds or loans).

SII has unexpectedly preceded IFRS rules for the definition of fair value for insurance contracts and managed to provide a consensus definition of the market consistent value of insurance contracts and of all non-hedgeable risks, i.e., risks that cannot be transferred on an exchange.

Technical provisions are defined as best estimate (average expected value of discounted cash flows, discounted at the risk-free rate), plus a market value margin (MVM) equal to the cost of borrowing the necessary regulatory capital over the maturity of the contract.

The full fair value approach makes it possible to define available capital as the difference between asset and liability values.
• SII has two levels of capital requirements
SII establishes a minimum capital requirement (MCR) equivalent to the Value-at-Risk with a 90% confidence interval and target capital or solvency capital requirement (SCR), calibrated to a 99.5% confidence interval.

23 - CEIOPS and the European Commission have alternated between the swap rate and the government bond rate. In QIS4 the swap yield curve is used as an input.
24 - Borrowing regulatory capital is assumed to cost 6% over the risk-free rate.
In the so-called traffic-light supervision system, the MCR is the red light, and any breach in the MCR leads to the withdrawal of the license to write new business, and it is expected that the insurance company will be taken over.

By contrast, the SCR is the green light, and as long as available capital exceeds the SCR there shall be no supervisory action as such.

In between is the orange zone, with closer supervision and more pressure on management to restore the company’s financials.

- SII has a modular approach
In SII, required capital results from the aggregation of capital charges for each risk type; these charges also result from the aggregation of the risk factors within a risk type. Each risk charge is measured as the one-year 99.5% VaR, and aggregation is done with a correlation matrix.

For market risk and for mortality risk, capital charges are estimated by means of scenario analyses: the impact of a given scenario on the market value of assets and liabilities must be estimated by the insurance company. The scenario is representative of a 99.5% confidence interval shift in a risk factor, and is generally given at the European level by CEIOPS, and at the national level by the respective supervisors of non-life catastrophe risk.

The map of risks is shown below.

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Figure 2.3: Solvency II map of risks.
Solvency capital requirements result from the aggregation of individual risk modules. We note that operational risk does not diversify away with other risk factors but is added to the aggregate of other capital charges. SCR=Solvency Capital Requirements; BSCR=Basic SCR; SCROP=Risk Charge for Operational Risk; Def=Default; NL=Non-Life; Pr=Reserve and Premium; Cat=Catastrophe; Mkt=Market; Conc=concentration; Fx=Foreign Exchange; Prop=property; Int=interest rate; Eq=equity; Sp=credit spreads; Health: ST=short-term; LT=long-term; WC=Worker’s Compensation; Life: Mort=mortality; Long=longevity; Rev=revision; Dis=disability; Exp=expense.

_adjustment for the risk-mitigating effect of future profit sharing_
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Mapping all the risks in the balance sheet with the SII categories and measuring them has allowed companies and supervisors that didn’t previously use this holistic approach to make significant progress.

• In spirit, SII recognises all risk-mitigation instruments. Unlike Solvency I, SII places no limits on risk transfer, such as reinsurance or securitisation. The residual risk of any risk transfer is measured as the default risk of the counterparty. Great changes are expected in the subscription process of reinsurance programs. For some reason, internal replication of optional payoffs and dynamic insurance of market risk are not recognised in the standard formula (see below).

• SII provides incentives to build internal models
Creating internal models and using them in the daily operations of the company, in particular in risk-management and capital planning makes it possible—as long as quality constraints are met—to replace capital charges as determined by the standard formula with capital charges as estimated by internal models.

• SII will lead to large changes in the management of risks
Solvency I was a hindrance to the management of insurance companies because of the discrepancy between regulatory capital and economic capital. The alignment of these two measures will create incentives to manage companies according to underlying economics, not to arbitrary rules.

Reinsurance programs will focus on risk capital, and on the credit risk of the reinsurer.

In product design, replicability and risk-sharing features may be of importance. In product pricing, consumption of risk capital as well as market value margin will be an input.

Dynamic asset management and ALM strategies will be applied where internal models are used.

2.2.3.2. SII’s standard formula should not be applied to pension funds because it does not recognise the role of the sponsor
• The short-term approach in SII is worrying for pension funds
Like Basel II for banks, SII takes a run-off approach to capital requirements. In other words, it assumes that the insurance company can go bankrupt at any time, in which case it is necessary to ensure sufficient assets remain so that another company will accept to run off residual assets and liabilities.

From this statement the horizon for risk measurement may sound logical: the MCR and the SCR are calibrated as a one-year Value-at-Risk.

Both the short-term measurement and the run-off approaches are particularly worrying for pension funds because they are long-term investors operating in a going-concern mode.

• Pension funds have a unique ability to behave as very long-term investors
This ability stems in part from the very long pension liabilities in their books,
2. The Regulatory and Accounting Context

but more than that, from the long-term ties that bind employers and employees. Pension funds are a sub-product of the employment contract, not a competitive financial service. This prevents the risk of client runs commonly faced by insurance companies and banking corporations, a risk that brings the investment horizon nearer. In pension funds, deficits do not make employees resign, as we have seen with General Motors.

- Pension funds operate in a going-concern mode, not in a run-off mode
  Again, because participation in a pension fund is mandatory, future increases in contributions (commonly referred to as inter-generational risk transfer) can erase deficits.

In addition, conventional last-wage benefits are, in a sense, an option on the firm’s success. So it may be desirable to finance these benefits out of any future income.

It is clear then that the short-term outlook inherent to SII is inappropriate for the longer horizon of pension funds.

- Pension funds cannot be likened to insurance companies
  One of the arguments in favour of applying SII to pension funds is that it would level the playing field for the providers of retirement benefits. As previously mentioned, however, pension funds are a by-product of the employment contract, not providers of financial services in competition with insurance companies.

- SII would lead to significantly higher funding requirements for pension funds
  SII implies that technical provisions are fully funded and that current assets include additional buffers for each risk class present over the short term.

First, technical provisions would, in most cases, rise markedly under Solvency II. SII requires that technical provisions be the best estimate cash flows discounted at the risk-free rate. Best estimate involves the use of the projected method, not the accrued liability as required by the IORP directive. The valuation of conditional indexation and future salary increases, and the use of a lower discount rate in the UK and Switzerland (where risk premiums are allowed in the calculation of the discount rates) are sources of increases for technical provisions.

In addition, buffers will be required. In practice, buffers are always positive even when the risk-absorbing capacity of internal buffers (such as conditional indexation) and external buffers (such as sponsor guarantees and flexibility in future contribution rates) should allow underfunding. 25

Overall, various studies conclude that funding requirements would be increased by 30% to 50% in many countries, with Germany the least affected (as guarantees are already discounted at a rate lower than the risk-free rate) and the UK the most severely affected.

The ability to take long-term risks would thus be severely curtailed, substantial cuts would be made in equity holdings, and ultimately the benefits provided to employees would undergo unwelcome change.

- Applying SII’s standard formula would very likely signal the death knell for DB pension funds because it would lead to

25 - In SII’s QIS2, the outcome of negative capital requirements was considered absurd by regulators and supervisors, even though it may have been a reality for some lines of business.
higher funding requirements and make it harder to take on investment risk and rewards.

Higher capital requirements mean higher pension costs for both employees and their sponsors, with immediate supplementary calls to increase the funding ratio to required levels. Less risk taking and fewer real assets mean that indexation will be less likely and that nominal rather than real benefits will be earned.

This situation would certainly speed up the rate at which DB plans are closed and replaced by DC schemes. Indeed, the Myners (2001; 2004) report argues that increased protection under DB plans will deprive UK employees of any DB plan at all.

Depriving UK employees of any DB is certainly inconsistent with the goals of prudential regulations to protect employee benefits.

Were the SII framework to be applied, the most important feature would probably be the authorisation to use internal models to set funding (capital) requirements, subject to regulatory approval. Approval is primarily conditioned on the use test, as detailed in the following sub-section.

2.2.3.3. Lessons from SII should be used in the revisions to the IORP directive

Although it is our opinion that SII’s standard formula is unfit for pension funds, some of the lessons learned in the process may yet contribute to improvement of the regulation of pension funds and should be used in the revision of the IORP directive. Were the directive to be made of three regulatory pillars, the following points could be included:

- **Pillar I: Valuation and capital requirements**
  1/Technical provisions: accrued benefits are probably the appropriate measure for funding purposes. However, the calculation of projected benefits, together with the buffers (the flexibility in benefits, much as with reduction of profit sharing for insurance companies), may be required as an indicator.
  2/Quantitative requirements: we argue that attention should be paid to the going-concern view. In other words, pension funds shall be required primarily to pass a continuity test that involves a stress scenario, as in SII, but by contrast includes the effect of future premiums--as with the similar tests in the UK and the Netherlands.
  3/Internal models: these models are probably more important for pension funds than for insurance companies. Pension funds are very heterogeneous, probably more so than insurance companies. Because of this heterogeneity, internal models (rather than a one-size-fits-all standard formula) should be favoured as a way to understand and disclose the risks.

- **Pillar II: governance and supervision**
  1/This second pillar is essential to SII. Because poor governance and risk management are often behind bankruptcies, the obligations relative to the second pillar should be reinforced in revisions of the IORP directive. Efficient external supervision is possible at reasonable cost for the supervisors only when companies prepare for it.
  2/Countries such as the Netherlands that have already adopted a three-pillar framework have also reinforced the second pillar.
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- Pillar III: communication and disclosures
  The IORP directive already contains elements of pillar III, with requirements to publish annual accounts and reports, reports for plan members, statements of investment policy principles, and disclosures to authorities. Pillar III is the least defined in SII, so it is hard to draw clear conclusions at this point.

The most important element of Solvency II, present in Dutch prudential regulation as well, is the possibility of setting funding requirements according to internal models, provided these are approved. Approval requires passing the so-called use test; in other words, the internal models must be used for the following:
- design of investment strategies, including rebalancing rules
- risk monitoring and limit setting, including stress testing and testing of the adequacy of strategies
- definition of the indexation policy
- planning of contribution and funding policy in a prospective manner (projecting the funding ratio in a scenario in which future contributions are raised for current and future employees).

When these tests are passed, funding requirements can be defined over a long-term horizon, the natural horizon for pension funds, as demonstrated in chapter 4.

2.3. Market Trends: Reaction to Tightening Regulations
Prudential and accounting regulations for pension funds have tightened greatly since 2000. This tighter regulation is the result not only of pension fund setbacks but also of the call for transparency of regulators and analysts.

Two competing effects are at play. First, prudential regulations may require higher funding requirements. Higher funding requirements mean a sudden increase in costs for sponsors that have complied with these requirements and are often negatively received.

Stricter funding requirements usually means less tolerance for underfunding or pension fund volatility; the P&L of the sponsors must reflect more swiftly any pension surpluses and deficits (this additional volatility in accounting earnings is not generally viewed with favour by the financial markets) or plans for faster recovery may be required.

Both the higher funding costs and the P&L volatility of the sponsor require action. As we will see in the points below and in chapter III, dynamic ALM and internal models can be used to manage stricter funding constraints as well as pension fund risk and volatility.

Cost control and the disappearance of the traditional last-wage DB pension plan
This historical standard for pension plans is to have initial pension payments calculated as a fraction of the last wage. Moreover, pension benefits were traditionally indexed either to an inflation index or to a wage index. In a simplified manner, the original pension benefit was structured as follows: the pension plan provides a yearly pension of, say, 2% of final salary for each year of service. The pension is payable from the age of sixty-five. Pension benefits
are indexed either to the official cost of living or to the wage index as calculated by the National Office for Statistics.26

The rationale is that wage-earners are accustomed to a certain standard of living, so their natural point of reference for post-employment earnings is the wage they receive at the end of their careers.

The following converging reasons have led to the gradual disappearance of this traditional scheme:
1/ High costs, because of improving mortality and reduction in observed as well as expected investment returns
2/ Abuses (increases in final pay check force the pension plan to provide large unplanned benefits to a particular employee)
3/ Desire to limit liability risk (last wage is less hedgeable than average wage)
4/ Stricter funding regulations and accounting standards (also with the measurement of liabilities as the projected liability for accounting purposes; see section 2.1.1).

Closures and the shift from DC to DB in the UK, conditional indexation in the Netherlands
In the OECD countries a move from DB to DC plans is underway. In eight of the twenty-one countries in the OECD area, more than half of pension plans were DC plans in 2004.

Shift away from DB in the UK
This shift was more pronounced in the United Kingdom, with a large wave of closures or even the freezing27 of DB schemes and proposals for DC schemes instead. According to the Pension Policy Institute, most DB schemes in the private sector are closed to new members.

It is worth noting that although closing DB schemes and replacing them with DC schemes makes it possible to reduce future costs and pension volatility, assets and liabilities from past service must still be managed.

In addition, pure DC plans involve risk and possible discontent for employees over the long run, as individuals often make poor investment decisions.

Conditional indexation in the Netherlands
In 2004, in the Netherlands, DB assets made up 91% of all occupational pension assets, according to OECD figures, a very high figure, as these plans are not mandatory.

The multi-employer exception to IAS 19—the usual form in the Netherlands, representing the bulk of pension assets—allows most sponsors to get around the problems posed by IAS 19 volatility. This multi-employer, industry-wide set-up is infrequent in the UK.

Defining indexation as conditional on the funding ratio of the pension fund alleviates the role of the sponsor in providing long-term guarantees but at the same time offers some of the essential risk-sharing and protection features of collective arrangements. In addition, it is a very efficient means for Dutch pension funds to comply with the significantly stricter funding requirements in the new Dutch prudential regulation.

Buy-out: the only way to transfer all regulatory constraints from existing DB funds
Sponsors that wish to be free of their commitment to employees have little

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26 - Many pension plans offer benefits in addition to old-age pensions—survivor’s, disability, sickness, maternity, adoption, and unemployment benefits.
27 - Closed schemes do not admit new members but existing members can continue to accrue benefits. Frozen (or paid-up) schemes do not admit new members; in addition, no further benefits accrue.
choice but to seek a buy-out. Here, sponsor commitments are taken on by a third party, e.g., an insurance company. Prudential funding constraints are then transferred to the insurance company that buys into pension assets and liabilities.

Financial techniques may be used—if necessary, by a fiduciary management company, advisors, or banking corporations—to shift financial risk away from the pension fund. However, because the market for longevity risk alone is relatively thin, companies that want to shed all risks from an existing DB scheme must resort to buy-outs.

Insurance companies require that assets be sufficient to cover the expected liability value, plus a price or buffer for the residual risk. Asymmetries of information, expected profitability, and required prudential buffers against risk push up the price for buy-outs.

Some banking corporations have sought to enter the buy-out market as they see pension liabilities as a source of stable funding over time and as a hedge against their own liquidity risks.

For the transfer of longevity risk, the main biometric risk for pension funds, solutions have yet to be found (see appendix of chapter III).

**Outsourcing**

For corporate pension funds whose sponsor is impacted by market volatility, two trends have emerged that make it possible to manage accounting volatility, and, to some extent, prudential constraints:

- **Outsourcing**: fiduciary management companies have gained market share, as they may provide more professional and cost-efficient management of pension plans and financial volatility.

For smaller pension funds, potential savings make these services an advantage. By increasing efficiency and achieving greater economies of scale, costs and investment could be lowered. It also makes it possible to draw on sophisticated models without investing in their construction and implementation: companies can adapt more easily to complex new legalisation if pension funds are outsourced, as they will have access to expert staff.

Outsourcing, of course, can take different forms. In partial outsourcing, for example, only part of a service is, as the name suggests, outsourced; the rest remains in-house. In full outsourcing all services except for contract management and staff are contracted out. In so-called contractorisation, used mostly by large schemes, a department in a company is taken over by an external supplier or by different external suppliers who take over different parts of the department. But even with full outsourcing the company keeps some responsibilities. It is up to the sponsor to decide which method is most suitable. It is worth noting as well that the administration, investment, custody, and investment back office components of pension fund management can each be separately outsourced. It is likewise possible to outsource certain parts of the pension fund portfolios—a derivatives programme, for example—in which sponsors may lack knowledge or experience.
2. The Regulatory and Accounting Context

*Advanced ALM strategies:* as explained in section 3.2, advanced ALM strategies can be understood as derivations of liability-driven investment (LDI), by which the replicating portfolio is separated from the strategic asset allocation. This technique may be used in-house, as with large Dutch pension funds, which have teams specifically to build ALM models and the resulting portfolios. It may also be provided by investment banks and asset management firms as portfolios made of swaps (for replication) and derivatives (for a protected strategic asset allocation).

Though regulations may involve biases, they must be taken into account in the design of the ALM strategy. As a matter of fact, risk aversion or low levels of wealth at the sponsoring company or in a pension fund may force the pension fund to adopt a prudent or even risk-free investment strategy, risk-free, that is, from the prudential regulator's point of view.

In this case, asset allocation will not merely need to take into account the presence of this constraint; instead, it will be governed entirely by the regulatory LHP, accounting or prudential, depending on which constraint is binding.

This study explores these constraints. They are then the business requirements necessary to build an efficient ALM model.

*On the development of internal models:* Mindful of promoting risk management, modern prudential regulations create incentives to use internal models. It does not matter whether they are developed internally or outsourced as long as they are used and understood by management. Larger pension funds are likely to develop their own models, but smaller DB funds will, in all likelihood, resort to fiduciary management companies that have invested in building models.
2. The Regulatory and Accounting Context
3. Asset–Liability Management for Pension Funds
3. Asset-Liability Management for Pension Funds

Introduction

Risk management techniques in asset–liability management were in the spotlight at the turn of the millennium

Market downturns have drawn attention to the risk management practices of institutional investors in general and defined benefit (DB) pension plans in particular. A perfect storm of adverse market conditions around the turn of the millennium left many corporate DB pension plans in ruins. Negative equity market returns eroded plan assets at the same time as declining interest rates increased the marked-to-market value of benefit obligations and contributions. In extreme cases, such as that of United Airlines, which had a pension fund deficit amounting to $9.8bn by mid-2005 and market capitalisation of well under $1bn, corporate pension plans have been left with funding gaps as large as or larger than the market capitalisation of the plan sponsor. In the UK alone, the FTSE 350 deficit was larger than £100bn on an FRS 17 basis through early 2003, and the average funding ratio was around 70%, though much lower for technology and energy, the hardest hit sectors, both of which had funding ratios below 60%. The aggregate UK pension deficit on an SF179 basis (guaranteed minimum liability discounted at the government bond yield) was also close to £100bn in March 2003, before recovering to close to zero in November 2003. From a surplus of £130bn in June 2007, aggregate pension net asset value fell into deficit in summer 2008; by December 2008 the deficit was almost £200bn.

That institutional investors, especially pension funds, have been so dramatically affected by recent market downturns suggests that their asset allocation strategies may not be consistent with sound liability risk management.

One question that naturally arises is whether better asset allocation decisions could have prevented the crisis. Another related question is whether it is possible to improve in the current situation and whether sound asset allocation practices can contribute to a resolution of the crisis. Research into asset allocation in the presence of liability constraints (also known as asset-liability management) has focused on extending Merton’s intertemporal selection analysis (1969, 1971) to account for the presence of liability constraints in the asset allocation policy.

In brief, the main insight of this research is that liability risk leads to the introduction of a specific hedging demand component in the optimal allocation strategy, as is the rule in intertemporal allocation decisions in the presence of stochastic state variables. But somewhat neglected by this research is how stiff constraints on the funding ratio (loosely defined as the ratio of the market value of assets to some liability) affect the optimal strategy.

The introduction of funding ratio constraints is an obviously desirable feature from a risk management standpoint, and they have been part of recent regulation in most developed countries, whether in the form of minimum funding constraints (Germany, the Netherlands) or a pension insurance scheme with a risk-based levy (the UK).
3. Asset-Liability Management for Pension Funds

This chapter presents a continuous-model for intertemporal allocation decisions in the presence of liabilities. We cast the problem in an incomplete market setting in which liability risk is not spanned by existing securities so as to account for the presence of non-hedgeable (e.g., longevity) sources of risk in liability streams. Using the martingale approach, where we treat the liability portfolio as a natural numeraire, we provide explicit solutions in the unconstrained case, as well as when explicit or implicit funding ratio constraints are imposed. In the unconstrained case, we confirm that the optimal strategy involves a fund separation theorem that legitimates investment in the standard efficient portfolio and a liability hedging portfolio and rationalizes the so-called liability-driven investment (LDI) solutions recently launched by several investment banks and asset management firms. The constrained solution, on the other hand, involves dynamic rather than static allocation to the standard efficient portfolio and a liability-hedging portfolio. These strategies are reminiscent of CPPI, which they extend to a relative (with respect to liabilities) risk context.

Because of its focus on asset allocation decisions with a liability benchmark, this model is also closely related to dynamic asset allocation models with performance benchmarks. Single-agent portfolio allocation models with benchmark constraints include Browne (2000) in a complete market setting, or Tepla (2001), who also includes constraints on relative performance. Another formally related paper is by Brennan and Xia (2002), who study in an incomplete market setting asset allocation decisions when an inflation index is used as a numeraire. Equilibrium implication of the presence of performance benchmarks is discussed in Cuoco and Kaniel (2003), Gomez and Zapatero (2003), or Basak, et al. (2002). This chapter is also related to the literature on portfolio decisions with minimum target terminal wealth, including Grossman and Vila (1989), Cox and Huang (1989), Basak (1995), or Grossman and Zhou (1996).

In addition, regulators are influencing the development of risk management practices, as a new wave of regulation is risk-based; in other words, it involves frameworks in which all risks need to be measured and buffers must be built against all sources of risks—regulatory constraints that may be stylised as Value-at-Risk constraints.

3.1. A Brief History of ALM Techniques

Institutional money managers have recently expressed a renewed interest in asset-liability management. LDI solutions have appeared in the wake of changes in accounting standards and regulations that have led to an increased focus on liability risk management. We provide below a brief review of standard asset allocation techniques used in ALM.

**Cash-flow matching and immunisation techniques**

Cash-flow matching involves ensuring a perfect static match between the cash flows from the portfolio of assets and the commitments in the liabilities. Leaving aside uncertainty relative to underwriting risk (uncertain longevity), when nominal (or real) amounts as well as their due dates are perfectly known today, it is possible to construct a portfolio of zero-coupon bonds (or zero-coupon inflation-linked bonds) that perfectly match commitments.
Though in theory simple, constructing the liability-hedging portfolio with inflation-linked bonds is in fact impossible with a low tracking error because it is generally impossible to find maturities that correspond exactly to the liability commitments. Moreover, most of those securities pay out coupons, which leads to the problem of reinvesting the coupons.

For this reason, the liability-hedging portfolio can also be constructed synthetically, using interest rates and inflation swaps, or one can resort to immunisation, which allows the residual interest rate risk created by the imperfect match between the assets and liabilities to be managed in a dynamic way. This technique can be extended to hedge for larger changes in interest rates (through the introduction of a convexity adjustment) or non-parallel shifts in the yield curve (Priaulet, et al. 2005) and to manage interest rate and inflation risk simultaneously (Siegel and Waring 2004).

It should be kept in mind, however, that modern portfolio construction techniques, as described in section 2.2, involve using the liability as a source of funding to take risk. As a consequence, only a fraction of the liability may be replicated. For instance, one may choose securities correlated with the LHP but with higher expected returns, in other words, making the LHP a source of funding for the strategic asset allocation.

The black-box flavour of surplus optimisation techniques

To improve the profitability of the assets, and therefore to reduce contributions, it is necessary to make asset classes (stocks, government bonds, and corporate bonds) that are not perfectly correlated with the liabilities part of the strategic allocation. Doing so will then involve finding the best possible compromise between the risk (relative to the liability constraints) thereby taken on and the excess return that the investor can hope to obtain through the exposure to rewarded risk factors. Different techniques are then used to optimise the surplus, in a risk/return space. Surplus optimisation involves two steps. The first consists of using a mathematical model to generate stochastic scenarios for all risk factors affecting assets and liabilities (interest rates, inflation, stock prices, real estate, etc.). Models are chosen so as to represent actual behaviour as accurately as possible and parameters are chosen so as to be consistent with long-term estimates. The next step involves using an optimisation technique to find the set of optimal portfolios.

For stochastic scenario simulation, main risk factors affecting asset and liability values are usually identified: interest rate risk (or, more accurately, interest rate risks since there is more than one risk factor affecting changes in the shape of the yield curve), inflation risk, stock prices, and possibly real estate risks. A standard example of a state-of-the-art ALM model is made available for public use by the Casualty Actuarial Society (CAS) and the Society of Actuaries (SOA) (see references). It involves a two-factor mean-reverting process for real interest rates, a one-factor mean-reverting process for the inflation rate, and a Markov regime-switching model for excess return on equity (excess return).

One of the appealing features of surplus optimisation models is that they can handle important practical issues such as
transaction costs, multiple state variables, and market incompleteness stemming from uncertainty in liability streams and not spanned by existing securities, taxes and trading limits, regulatory restrictions, and corporate policy requirements. On the other hand, these features come at the cost of tractability. Analytical solutions are not possible, and stochastic programming models must be solved via numerical optimisation. For optimisation, several technological choices are also available. While dynamic optimisation with time- and state-dependent solutions has been analysed from an academic standpoint (Ziemba and Mulvey 1998), as well as Kallberg et al. (1982), Kusy and Ziemba (1986), Mulvey and Vladimirou (1992), Gondzio and Kouwenberg (1999), most (if not all) industry applications, even the most sophisticated, in fact involve static solutions. In other words, because of the numerical complexity of dealing with very general time- and state-dependent strategies, the optimal allocation is a solution to a constrained optimisation problem, in which the set of strategies under consideration includes only strategies with fixed weights.  

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A fixed-mix, however, is optimal only under very restrictive assumptions—for instance, when there are no liabilities in the portfolio problem and when the opportunity set is constant. In this section, we present a formal model of asset–liability management in a stylised setting and use it to generate insights into what an optimal solution might look like from an analytical standpoint. These insights are particularly useful in a richer and more realistic surplus optimisation setting. Rule-based strategies drawn from a clear representation of the liability hedging portfolio, the risk-budgeting process, and institutional constraints allow great improvement in the terminal distribution of the surplus and in the volatility of contributions or of the sponsor’s P&L under IAS 19. Risk-budgeting leads to solutions similar to those of the recently developed LDI.

Our model focuses on pension funds, taken in isolation from the sponsor company. Abstracting away from the sponsor company permits simplification. It is possible to account first for the presence of (exogenous) contributions from the sponsor company to the pension fund, while maintaining the focus on the pension fund objective. Hedging sponsors’ risk would justify the introduction of an additional “fund”. More broadly, it is possible to take a corporate-finance approach to asset–liability management, with a focus on optimal allocation and contribution policies from the shareholders’ standpoint. But this approach would require a formal analysis of the rational valuation of liability streams as defaultable claims, analysis that would incorporate the impact of asset allocation decisions on credit ratings.

25 - One of the first successful commercial multistage stochastic programming applications appears in the Russell-Yasuda Kasai model (Cariño et al. 1994, 1998, Cariño and Ziemba 1998). Other successful commercial applications include the Towers Perin-Tillinghast ALM system of Mulvey et al. (2000), the fixed-income portfolio management models of Zmios (1996) and Beltratti et al. (1999), and the InnoALM system of Geyer et al. (2001).

36 - See comments in section 4.1.1.iv
LDI solutions identify the key block necessary to ALM

Surplus optimisation typically allow for higher return (on average), and hence lower contributions (on average), since they lead to the introduction of risky asset classes, with the access to associated risk premia. On the other hand, they introduce a significant source of risk since asset classes poorly correlated with liabilities are introduced. In an attempt to mitigate these risks, and enhance liability risk management, a new approach known as LDI has recently been proposed, which is based on the introduction of a liability-hedging portfolio in the menu of asset classes. It thus builds on the traditional approach of cash-flow matching and immunisation, focused on risk management, to which it adds a component dedicated to performance.

It should be noted that when the liability matching portfolio is available in the menu of asset classes, the minimum risk solution of surplus optimisation corresponds to the cash-flow matching strategy, which is thus recovered as a specific case. This discussion might suggest that so-called LDI solutions are in fact merely a specific case of surplus optimisation techniques, in a context in which a liability-matching (or liability-hedging) portfolio is available in the menu of asset classes. There is a somewhat subtle difference, though, between LDI solutions and surplus optimisation with a liability-matching portfolio (see in particular Leibowitz and Weinberger (1982a; 1982b) for the contingent optimisation technique, as well as Amenc et al. (2004) with a generalisation in terms of dynamic core-satellite management, for heuristic approaches that exhibits similar features).

Such dynamic allocation methods, formalised in chapter III, attempt to deliver the best of both worlds (downside risk protection and access to upside potential). They are inspired by portfolio insurance techniques, which they extend to an ALM framework.

Overview of ALM techniques

The following exhibit presents an overview of ALM techniques and the corresponding techniques in asset management.
3. Asset-Liability Management for Pension Funds

3.2. A formal ALM model

In this section, we introduce a general continuous-time asset allocation model in the presence of liability constraints. As recalled in section 3.1, this continuous-time stochastic control approach to ALM is appealing in spite of its highly stylised nature because it leads to a tractable solution, allowing one to fully and explicitly understand the various mechanisms affecting the optimal allocation strategy. In short, the long-term investor with constant relative risk aversion will adopt a fixed-mix strategy; when a minimum funding ratio is required, the investment strategy will exhibit a convex exposure to risky assets–as in portfolio insurance, exposure to risk is diminished when the surplus falls.

We let \([0,T]\) denote the (finite) time span of the economy, where uncertainty is described through a standard probability space \((\Omega, \mathcal{A}, P)\) and endowed with a filtration \(\{F_t; t \geq 0\}\) where \(F_\infty \subset \mathcal{A}\) and \(F_0\) is trivial, representing the \(P\)-augmentation of the filtration generated by the \(n\)-dimensional Brownian motion \(\{W_i; i = 1, \ldots, n\}\).

### Table 3.1: Overview of ALM techniques and the corresponding techniques in asset management.

The table illustrates the evolution of ALM techniques, from cash-flow matching to dynamic liability-driven investments.

<table>
<thead>
<tr>
<th>Risk/Return Profile</th>
<th>Asset Management (absolute risk)</th>
<th>Asset-Liability Management (relative risk)</th>
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</thead>
<tbody>
<tr>
<td>Zero risk – no access to risk premia</td>
<td>Investment in risk-free asset</td>
<td>Cash-flow matching and/or immunisation</td>
</tr>
<tr>
<td>Optimal risk-return trade-off</td>
<td>Optimally diversified portfolio of risky assets</td>
<td>Optimisation of the surplus</td>
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<tr>
<td>Fund separation theorem</td>
<td>Capital market line (static mix of cash and optimal performance-seeking risky portfolio)</td>
<td>LDI solution (static mix of cash, liability-matching portfolio and optimal risky portfolio)</td>
</tr>
<tr>
<td>Dynamic and skewed risk management (non-linear payoffs)</td>
<td>Portfolio insurance (dynamic mix of risk-free asset and optimal risky portfolio)</td>
<td>Dynamic LDI (also known as contingent immunisation)</td>
</tr>
</tbody>
</table>

#### 3.2.1. A stochastic model for assets and liabilities

We consider \(n\) risky assets, the prices of which are given by:

\[
dP_i = P_i \left( \mu_i dt + \sum_{j=1}^{n} \sigma_{ij} dW_j \right), \quad i = 1, \ldots, n
\]

We shall sometimes use the shorthand vector notation for the expected return (column) vector \(\mu = (\mu_1, \ldots, \mu_n)\) and matrix notation \(\sigma = (\sigma_{ij}; i, j = 1, \ldots, n)\) for the asset return variance-covariance matrix. We also denote denote \(1 = (1, \ldots, 1)\) a \(n\)-dimensional vector of ones and by \(W = (W_i; i = 1, \ldots, n)\) and the vector of Brownian motions. A risk-free asset, the \(0\)-th asset, is also traded in the economy. The return on that asset, typically a default-free bond, is given by \(dP_0 = P_0 r dt\), where \(r\) is the risk-free rate in the economy.

We assume that \(r, \mu\) and \(\sigma\) are progressively-measurable and uniformly bounded processes, and that \(\sigma\) is a non-singular matrix that is also progressively measurable and bounded uniformly.\(^{37}\) For some numerical applications below, we will sometimes treat these parameter values as constant.

---

\(^{37}\) More generally, one can make expected return and volatilities of the risky assets, as well as the risk-free rate, depend on a multi-dimensional state variable \(X\). These state variables can be thought of as various sources of uncertainty impacting the value of assets and liabilities. In particular, one may consider the impact of stochastic interest rate or inflation on the optimal policy.
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Under these assumptions, the market is complete and arbitrage-free and there exists a unique equivalent martingale measure $Q$. In particular, if we define the risk premium process $\theta_t = \alpha^{-1} (\mu_t - r_t)$, then we have that the process

$$Z(0,t) = \exp \left( -\int_0^t \theta_s \, ds - \frac{1}{2} \int_0^t \theta_s^2 \, ds \right)$$

is a martingale, and $Q$ is the measure with a Radon-Nikodym density $Z(0,t)$ with respect to the historical probability measure $P$.

By the Girsanov theorem, we know that the n-dimensional process defined by

$$(\mathcal{W}_t)^a = (W_t + \int_0^t \theta_s \, ds)_{t \geq 0}$$

is a martingale under the probability $Q$. The dynamics of the price process can thus be written as:

$$\frac{dP}{P_t} = rd\tau + \sigma d\mathcal{W}_t^a = rd\tau + \sigma (d\mathcal{W}_t + \theta d\tau)$$

(1)

We also introduce a separate process that represents in a reduced-form manner the dynamics of the present value of the liabilities. In particular, it could represent the present value of a series of inflation-protected cash flows.

The model we use is:

$$dl_t = l_t (\mu_t dt + \sum_{j=1}^n \sigma_{t,j} d\mathcal{W}_t^j + \sigma_{t,v} d\mathcal{W}_t^v)$$

where $\mathcal{W}_t^v$ is a standard Brownian motion, uncorrelated with $\mathcal{W}_t$ that can be regarded as the residual of the projection of liability risk onto asset price risk and represents the source of uncertainty that is specific to liability risk, and cannot be spanned by existing financial securities.

The integration of the above stochastic differential equation gives

$$l_t = l_t \eta_t \exp \left( \int_0^t (\mu_s - r_s) \, ds + \int_0^t \sigma_s \, dW_s \right)$$

where $\eta_t = \exp \left( -\int_0^t \alpha_s \, ds \right)$ with:

$$\eta_t = \exp \left( \int_0^t \sigma_s \, dW_s + \int_0^t \alpha_s \, ds \right)$$

When $\alpha_{t,v} = 0$, then we are in a complete market situation where all liability uncertainty is spanned by existing securities. Because of the presence of non-financial (e.g., actuarial) sources of risk, such a situation is not always to be expected in practice, and the correlation between changes in value in the liability portfolio and the liability-hedging portfolio (the LHP, i.e., the portfolio with the highest correlation with liability values) is typically strictly lower than one.

If such a hypothetical perfect liability-hedging asset is available, and assuming it is the nth asset, we then have $\mu_t = \mu_t$, $\sigma_{t,j} = \sigma_{t,j}$ for all $j$, and $\sigma_{t,v} = 0$. In general, however, $\sigma_{t,v} \neq 0$ and the presence of liability risk that is not spanned by asset prices induces a specific form of market incompleteness. Amen et al. 2006 characterized the set of equivalent martingale measures in the presence of liability risk that is not spanned (by existing securities), by first considering the standard case in which the risk-free asset is used a numeraire and then moving to that in which the liability portfolio is used as a numeraire, a natural choice, as argued in the next sub-section.

3.2.2. Objective function and investment policy

The investment policy is a (column) predictable process vector $\mathcal{W}_t = (w_{t,0}, ..., w_{t,n})$ that represents allocations to risky
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assets, with the remainder invested in the risk-free asset. We define by $A^w$ the asset process, i.e., the wealth at time $t$ of an investor following the strategy $w$ starting with an initial wealth $A_0$.

We have that:

$$dA^w = A^w \left[ (1-w')dP_t^0 + w'dP_t^1 \right]$$

or:

$$dA^w = A^w \left[ (r + w'(\mu - r1))dt + w' \sigma dW_t \right]$$

We now introduce one important state variable in this model, the funding ratio, defined as the ratio of assets to liabilities: $F_t = A_t / L_t$. We say that a pension fund is overfunded when the funding ratio is greater than 100%, fully funded when it is 100%, and underfunded when it is less than 100%.

As argued before, an important component of asset-liability management is that the institutional investor’s objective is written in terms of relative wealth (relative to liabilities), as opposed to absolute wealth: $\max L_t \{ U(F_t) \}$. From a technical standpoint, a change of numeraire, by which the liability value, and not the risk-free asset, is used as a numeraire portfolio, is effected.

Using Itô’s lemma, we can also derive the stochastic process followed by the funding ratio under the assumption of a strategy $w$:

$$dF^w = d\left( \frac{A^w}{L_t} \right) = \frac{1}{L_t} dA^w - \frac{A^w}{L_t} dL_t - \frac{1}{L_t} dA^w dL_t + \frac{A^w}{L_t} (dL_t)^2$$

which yields:

$$\frac{dF^w}{F^w} = \left( (r + w'(\mu - r1))dt + w' \sigma dW_t \right) - \left( \mu_t dt + \sigma_t dW_t + \sigma_{t'} dW_{t'} \right) - \left( w' \sigma dW_t \right) + \left( (\sigma_t \mu_t + \sigma_{t'} \sigma_t) dt \right)$$

For later use, let us define the following quantities as the mean return and volatility of the funding ratio portfolio, subject to a portfolio strategy $w$:

$$\mu^w = (r + \sigma_t \mu_t + \sigma_{t'} \sigma_t) + w'(\mu - r1) - \sigma_t \sigma_{t'}$$

$$\sigma^w = \sqrt{(w' \sigma dW_t) + (\sigma_t \mu_t + \sigma_{t'} \sigma_t)^2}$$

3.2.3. The solution to the optimal allocation involves three blocks: the cash-account, risky assets and the liability hedging portfolio

We now solve the optimal asset allocation problem in the presence of liability risk using the martingale, or convex duality, approach to portfolio optimisation.\(^{39}\)

Solving the optimal allocation problem via a martingale approach is a two-step process. The first step is to determine the optimal asset value among all possible values that can be financed by some feasible trading strategy. The second step is to determine the portfolio policy financing the optimal terminal wealth. In a complete market setting, the uniqueness of the equivalent martingale measure allows for a simple static budget constraint. In this incomplete market setting, we show in the following theorem that a similar line of reasoning applies, based on the fact that the investor can vary the asset value across states of the world represented by the uncertainty spanned by existing securities. Intuitively, the uncertainty that is specific to liability risk, because it is independent of asset price uncertainty, induces some form of
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Incompleteness that does not directly affect the asset allocation decision.

**Theorem 1**
The optimal terminal funding ratio obtained as a solution to the program:

\[
\max_{\lambda} \mathbb{E}_t \left[ \left( \frac{A^*}{L^*} \right)^{1-\gamma} \right], \text{ such that: } E_t^\lambda \left[ \frac{A}{L} \right] = \frac{A}{L},
\]

where \((A)\) is financed by a feasible trading strategy with initial investment \((A_0)\), is given by:

\[
F_t^* = \frac{A_t^*}{L_t} = \left( \frac{\sigma}{\lambda} \right)^{1-\gamma} \mathbb{E}_t \left[ \left( \frac{\xi(t,T)}{\eta(t,T)} \right)^{1-\gamma} \left( E_t \left[ \frac{\xi(t,T)}{\eta(t,T)} \right] \right)^{-\gamma} \right]^{1-\gamma} \left( \frac{\xi(t,T)^{-\gamma}}{\eta(t,T)^{-\gamma}} \right)^{-\gamma}.
\]

while the optimal portfolio strategy is:

\[
w = \frac{1}{\gamma} \left( \sigma \lambda \right)^{-1} \left( \mu - rt \right) + \left( 1 - \frac{1}{\gamma} \right) \left( \lambda \right)^{-1} \lambda.
\]

Proofs for this and other theorems can be found in previous EDHEC publications, e.g., Amenc et al. (2006):

We thus obtain a three-fund separation theorem, where the optimal portfolio strategy consists of holding two funds, one with weights

\[
w = \frac{1}{\left( \sigma \lambda \right)^{-1} \left( \mu - rt \right) + \left( 1 - \frac{1}{\gamma} \right) \left( \lambda \right)^{-1} \lambda}
\]

and another one with weights

\[
w = \frac{\lambda \lambda}{\left( \lambda \right)^{-1} \lambda}, \text{ the remainder being invested in the risk-free asset.}
\]

The first portfolio is the standard mean-variance efficient portfolio. Note that the amount invested in that portfolio is directly proportional to the investor’s Arrow-Pratt coefficient of risk-tolerance

\[
\frac{J}{E_t} = \frac{1}{\gamma}.
\]

(If the inverse of the relative risk aversion). This makes sense: the higher the investor’s (funding) risk tolerance, the higher the allocation to that portfolio will be.

In order to better understand the nature of the second portfolio, it is useful to remark that it minimises the local volatility \(\sigma_t^\lambda\) of the funding ratio. To see this, recall that the expression for the local variance is given by

\[
\sigma_t^2 = \left( w^\lambda \sigma - \sigma \right) \left( w^\lambda \sigma - \sigma \right) + \alpha_t^\lambda\gamma, \]

which reaches a minimum for \(w^\lambda = \left( \sigma' \right)^{-1} \alpha_t^\lambda\), with the minimum being \(\sigma_t^\lambda\). As such, it appears as the equivalent of the minimum variance portfolio in a relative return-relative risk space, as well as the equivalent of the risk-free asset in a complete market situation where liability risk is entirely spanned by existing securities \((\alpha_t^\lambda = 0)\). Alternatively, this portfolio can be shown to have the highest correlation with the liabilities. As such, it can be called a liability-hedging portfolio, in the spirit of Merton’s (1971) intertemporal hedging demands. Indeed, if we want to maximise the covariance \(w^\lambda \sigma \lambda\) between the asset portfolio and the liability portfolio \(L\), under the constraint that \(\sigma_t^\lambda = w^\lambda \sigma \lambda\), we obtain the following Lagrangian:

\[
L = w^\lambda \sigma \lambda - \lambda \left( w^\lambda \sigma \lambda - \sigma_t^\lambda \right).
\]

Differentiating with respect to \(w\) yields:

\[
\frac{\partial L}{\partial w} = \sigma_t^\lambda - 2 \lambda \alpha_t^\lambda \alpha_t^\lambda, \text{ with a strictly negative second derivative function.}
\]

Setting the first derivative equal to zero for the highest covariance portfolio leads to the following portfolio, which is indeed proportional to the liability-hedging portfolio

\[
w = \frac{1}{2\lambda} \left( \sigma' \right)^{-1} \alpha_t = \frac{1}{2\lambda} \left( \sigma' \right)^{-1} \alpha_t.
\]

In addition, when \(\gamma = 1\), i.e., in the case of the log investor, the intertemporal hedging demand is zero (myopic investor).
3. Asset-Liability Management for Pension Funds

In principle, one should therefore distinguish between liability matching, when a perfect match between asset and liability cash-flows is available (see figure 3.1), and liability hedging, which describes situations when a perfect match is not available (see figure 3.2).

3.2.4. From static to dynamic asset allocation decisions

We have seen previously that the optimal strategy consists of holding two funds, in addition to the risk-free asset, the standard mean-variance portfolio and the liability hedging portfolio.

Figure 3.1: Surplus optimisation without a liability-matching portfolio

Without a liability-matching portfolio that makes possible full shedding of liability risk, risk cannot be reduced below a strict minimum. In a classical manner, the efficient frontier forms a convex set of possible portfolios.

Figure 3.2: Surplus optimisation with a liability-matching portfolio

When a liability-matching portfolio is available, risk can be reduced to zero. In addition, the efficient frontier is linear.
The proportions invested in these two funds are constant and given by
\[
\frac{1'}{(\sigma')^{-1}} (\mu - r_1)
\]
and \( \left(1 - \frac{1}{\gamma}\right)(\sigma')^{-1} \sigma_1 \) respectively.

In what follows, we consider an interesting extension where the optimal strategy involves a dynamic rebalancing of the two aforementioned portfolios, even in the absence of a stochastic opportunity set. The ingredient that we introduce is the presence of constraints on the funding ratio, which, as recalled in the introduction, are dominant in pension funds' environment. As noted by Basak (2002) in a different context, there can be two types of constraints, explicit or implicit.

In a program with explicit constraints, marginal indirect utility from wealth discontinuously jumps to infinity:

\[
\max_{w_t, s \leq t \leq T} E_t \left[ \frac{(A_t - k)}{L_t} \right]^{1 - \gamma},
\]
such that \( A_t \geq k L_t \) almost surely. In what follows, we focus instead on a program with implicit constraints, where marginal utility goes smoothly to infinity, and which can be written as:

\[
\max_{w_t, s \leq t \leq T} E_t \left[ \frac{(A_t - k)}{L_t} \right]^{1 - \gamma}
\]

The following theorem provides the solution to this constrained optimisation problem in the complete market case. In the incomplete market setup, the presence of a non-hedgeable source of risk will make it impossible for the (implicit) constraint to hold almost surely.

**Theorem 2**

In the complete market case, the optimal terminal funding ratio obtained as a solution to the program

\[
\max_{w_t, s \leq t \leq T} E_t \left[ \frac{(A_t - k)}{L_t} \right]^{1 - \gamma},
\]
such that:

\[
E_t \left[ \frac{(A_t - k)}{L_t} \right] = \frac{A_t}{L_t},
\]

where \( (A_t) \) is financed by a feasible trading strategy with initial investment \( (A_0) \), is given by:

\[
F_t = E_t \left[ (\xi (t,T))^{1 - \gamma} + k \xi (t,T) \right]^{1 - \gamma} \xi (t,T)^{1 - \gamma} + k
\]

while the optimal portfolio strategy is

\[
w^* = \frac{1'}{1 - \frac{1}{\gamma}} (\sigma^')^{-1} (\mu - r_1)
\]

\[
+ \left(1 - \frac{1}{\gamma} \frac{1}{F_t} \right) (\sigma^')^{-1} \sigma_1
\]

For a given value of the risk-aversion parameter, the investment in the log-optimal portfolio is lower than in the absence of liability constraints since

\[
\left(1 - \frac{k}{F_t} \right) < 1
\]

and it decreases as the funding ratio decreases toward the threshold. The recommendation is therefore for better funded pension funds to have more aggressive policies, while pension funds in worsening financial situations should have less aggressive policies.

It should also be noted that the fraction of wealth allocated to the optimal growth portfolio

\[
w_m = \frac{(\sigma^')^{-1} (\mu - r_1)}{1' (\sigma^')^{-1} (\mu - r_1)}
\]

is given by
Therefore, if we define the floor as $kL_t$, i.e., the value of liability that is consistent with the constraint, and the cushion as $A_t - kL_t$, we obtain that the investment in the growth optimal portfolio is always equal to a constant multiple $m$ of the difference between the asset value and the floor. That constant coefficient is

$$ m = \frac{1'}{\gamma} (\alpha')^{-1} (\mu - r) \left( A_t - A_k \frac{F_t}{A} \right) $$

This is strongly reminiscent of CPPI (constant proportion portfolio insurance) strategies, which the present set-up extends to a relative risk management context. While CPPI strategies are designed to prevent final terminal wealth from falling below a specific threshold, such extended CPPI strategies are designed to prevent asset value from falling below a pre-specified fraction of some benchmark value. To the best of our knowledge this result is novel and rationalises the so-called contingent optimisation technique, a concept introduced by Leibowitz and Weinberger (1982a; 1982b) with no theoretical justification, which it further extends to the relative risk context.

On the other hand, the fraction of wealth allocated to the liability hedging portfolio

$$ w_t = \frac{(\alpha')^{-1} \sigma_t}{1'(\alpha')^{-1} \sigma_t} $$

is given by

$$ \frac{(\alpha')^{-1} \sigma_t}{1'(\alpha')^{-1} \sigma_t} \left( A_t - \frac{1}{\gamma} \left( A_t - kL_t \right) \right) $$

The investment in the liability-hedging portfolio is always equal to a constant multiple $m'$ of the difference between the asset value and the cushion divided by the coefficient of risk-aversion. The multiplier coefficient is

$$ m' = \frac{(\alpha')^{-1} \sigma_t}{1'(\alpha')^{-1} \sigma_t} $$

3.2.5. Note on the construction of the performance seeking portfolio

The three-fund separation theorem presented above provides formal justification for recent so-called LDI solutions offered by several investment banks and asset management firms. In a nutshell, these solutions advocate allocation strategies based on investment in two underlying building blocks (in addition to the risk-free asset), the standard optimal growth portfolio and a liability-hedging portfolio.

In other words, these solutions involve separating the management of risk (through the liability-hedging portfolio) and the management of performance. In this context the use of risk management techniques, as opposed to simple asset management techniques, is critical in the design of the performance-seeking portfolio. EDHEC research has shown that the design of the performance-seeking portfolio should be cast in the context of the core-satellite approach to portfolio construction, which has proven to be an efficient way to disentangle the search for alpha (abnormal returns emanating from active portfolio management) and the search for beta (normal returns emanating from a diversified exposure with respect to rewarded sources of risk).
3. Asset-Liability Management for Pension Funds

Risk management can be achieved in two possible ways, one being the reduction of risk through proper asset allocation decisions (diversification benefits), the other being the elimination of risk through the use of suitably designed solutions based either on derivative instruments or dynamic asset allocation strategies (hedging benefits). We invite the reader to refer to past studies (Amenc et al. 2006).

3.3. The Implementation of the Liability-Hedging Portfolio for Hedgeable Risks: Cash Contracts and Derivatives

3.3.1. Use of cash contracts in the implementation of the liability-hedging portfolio

The formal ALM model described in the previous section has conceptual features that are essential in building brick by brick the optimal asset portfolio. The first step consists in the identification of the liability-hedging portfolio, i.e., the portfolio of assets that has the closest match with liabilities.

In this section, we will give practical insights into the reasons for building liability-hedging portfolios and describe the instruments that can be used for that purpose.

The discussion in this section is concerned mainly with hedgeable risk, risk that can be fully transferred to the securities market. Nominal and inflation-linked cash flows are examined. We argue that, while cash instruments such as bonds can be used in the design of liability-hedging portfolios, derivatives instruments such as futures and swaps typically allow for a more efficient replication of the interest rate and—if necessary—inflation risk present in liability structures. Non-linear exposures may require either derivatives or specific over-hedging strategies.

Various instruments can be used to design the LHP and the strategic asset allocation. After all, both portfolios are defined as exposures to risk factors, a definition that leaves the choice of instruments to be used for implementation to the ALM and asset management teams.

The exact mix of cash instruments and derivatives for replication and risk taking depends on the organisation of the pension fund and on the constraints that may bind replication and risk taking.

In this section, we consider two distinct cases: one in which liability risk factors are essentially replicated with cash instrument derivatives used for risk taking and another in which derivatives are used to implement the LHP and cash instruments to allocate assets strategically.
The size of the premium is €45.7M net of all fees. The term date is 2028. There is a guaranteed yield of 1% per annum, and accumulated savings are always inflation protected. Here, the reserves increase according to the following formula: Reserves\((t) = \text{Reserves}(t-1) \times 1.01 \times (1 + \text{inflation}(t))\). This means that the €45.7M premium, with a 1% real yield and inflation protected, is equivalent to €45.7 \times (1+1%)^{20} = €55.76M in real terms.

In this simple example all payments are real payments with known maturities and thus can be replicated by real instruments, such as inflation-linked (real) bonds. Though an inflation-linked bond that has approximately the same maturity as the liability can help reduce inflation risk, it would not perfectly replicate the liability. Cash-flow matching would require being short real bonds with lower maturities to offset the impact of coupons paid on inflation-linked bonds.

We are considering a zero-coupon inflation yield curve that rises linearly from 2% in year one to 2.9% in year 20, and a zero-coupon yield curve that rises linearly between 4% and 5%.

The replicating portfolio of real bonds is as follows:

Table 3.2: Replicating portfolio made of real bonds

<table>
<thead>
<tr>
<th>Index</th>
<th>Nominal of Instruments</th>
<th>Market Value</th>
<th>Real Interest Rate</th>
<th>Instrument</th>
<th>End Date</th>
<th>CPI ZC Curve</th>
<th>Risk-free Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.76</td>
<td>-0.76</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2009</td>
<td>2.0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>2</td>
<td>-0.78</td>
<td>-0.78</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2010</td>
<td>2.1%</td>
<td>4.1%</td>
</tr>
<tr>
<td>3</td>
<td>-0.79</td>
<td>-0.79</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2011</td>
<td>2.1%</td>
<td>4.2%</td>
</tr>
<tr>
<td>4</td>
<td>-0.81</td>
<td>-0.81</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2012</td>
<td>2.2%</td>
<td>4.2%</td>
</tr>
<tr>
<td>5</td>
<td>-0.83</td>
<td>-0.83</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2013</td>
<td>2.2%</td>
<td>4.3%</td>
</tr>
<tr>
<td>6</td>
<td>-0.84</td>
<td>-0.84</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2014</td>
<td>2.3%</td>
<td>4.3%</td>
</tr>
<tr>
<td>7</td>
<td>-0.86</td>
<td>-0.86</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2015</td>
<td>2.3%</td>
<td>4.4%</td>
</tr>
<tr>
<td>8</td>
<td>-0.88</td>
<td>-0.88</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2016</td>
<td>2.4%</td>
<td>4.4%</td>
</tr>
<tr>
<td>9</td>
<td>-0.89</td>
<td>-0.89</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2017</td>
<td>2.4%</td>
<td>4.5%</td>
</tr>
<tr>
<td>10</td>
<td>-0.91</td>
<td>-0.91</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2018</td>
<td>2.5%</td>
<td>4.5%</td>
</tr>
<tr>
<td>11</td>
<td>-0.93</td>
<td>-0.93</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2019</td>
<td>2.5%</td>
<td>4.6%</td>
</tr>
<tr>
<td>12</td>
<td>-0.95</td>
<td>-0.95</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2020</td>
<td>2.5%</td>
<td>4.6%</td>
</tr>
<tr>
<td>13</td>
<td>-0.97</td>
<td>-0.97</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2021</td>
<td>2.6%</td>
<td>4.7%</td>
</tr>
<tr>
<td>14</td>
<td>-0.99</td>
<td>-0.99</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2022</td>
<td>2.6%</td>
<td>4.7%</td>
</tr>
<tr>
<td>15</td>
<td>-1.01</td>
<td>-1.01</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2023</td>
<td>2.7%</td>
<td>4.8%</td>
</tr>
<tr>
<td>16</td>
<td>-1.03</td>
<td>-1.03</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2024</td>
<td>2.7%</td>
<td>4.8%</td>
</tr>
<tr>
<td>17</td>
<td>-1.05</td>
<td>-1.05</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2025</td>
<td>2.8%</td>
<td>4.9%</td>
</tr>
<tr>
<td>18</td>
<td>-1.07</td>
<td>-1.07</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2026</td>
<td>2.8%</td>
<td>4.9%</td>
</tr>
<tr>
<td>19</td>
<td>-1.09</td>
<td>-1.09</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2027</td>
<td>2.9%</td>
<td>5.0%</td>
</tr>
<tr>
<td>20</td>
<td>54.65</td>
<td>54.65</td>
<td>2.0%</td>
<td>ILBOND</td>
<td>2028</td>
<td>2.9%</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

Note: Nominal is equal to market value because it is assumed that bonds are bought at par value.
3. Asset-Liability Management for Pension Funds

In this case, the portfolio is worth €37M and €54M needs to be invested in a twenty-year real bond. Moreover, perfect replication of the liability is never possible because of the lack of available maturities in the inflation-linked market. In addition, any portfolio that cannot be short bonds would be significantly different from the replicating portfolio, and thus have greater risk. When an LHP with a low tracking error is preferred, derivatives may be used instead of cash contracts (see the illustration of zero-coupon inflation swaps in section 3.3.1.2) or as an overlay to adjust for the residual risk in the LHP.

Box: Use of repo transactions to enhance yields

When the LHP—which consists of risk factors—is implemented with cash instruments, it is common for the risk budget available for strategic asset allocation (SAA) to exceed the Value-at-Risk of the optimal portfolio constructed with cash instruments, so SAA will require leverage.

Repo transactions can be used for this purpose, as they make it possible to increase returns on the T-Bond and IL-Bond portfolios used for replication. Repo transactions, as an alternative to swap and futures transactions, can also be used to adjust the duration of a bond portfolio. This box describes repo transactions; it also illustrates their use in interest rate risk management.

Repurchase (repo) and reverse repurchase (reverse repo) agreement transactions are commonly used by traders and portfolio managers to finance either long or short positions (usually in government securities). A repo is a means for an investor to lend bonds in exchange for a loan of money; more precisely, a repo agreement is a commitment by the seller of a security to buy it back from the buyer at a specified price and at a given future date. It can be viewed as a collateralised loan, with the security as the collateral. A reverse repo agreement is the same transaction viewed from the buyer’s perspective. The repo desk acts as the intermediary between the investors who want to borrow cash and lend securities and the investors who want to lend cash and borrow securities. The borrower of cash will pay the bid repo rate times the amount of cash borrowed while the lender of cash will get the ask repo rate times the amount of cash lent. The repo desk gains the bid-ask spread on all the deals for which it is the broker.

Consider an investor who lends €1M in ten-year Bund benchmark bonds (i.e., the Bund 5% 07/04/2011 with a quoted price of 104.11 on 10/29/2001) over one month at a repo rate of 4%. There is 160 days’ accrued interest as of the starting date of the transaction. At the beginning of the transaction, the investor will receive an amount of cash equal to the gross price of the bond times the nominal of the loan, that is: \[(104.11+5×117/360)%×1,000,000= 1,057,350.\]

At the end of the transaction, in order to repurchase the securities he will pay the amount of cash borrowed plus the repo interest due over the period, that is: \[1,057,350×(1+4%×30/360)= 1,060,875.\]
3.3.2. Cash-saving instruments for the implementation of liability-hedging portfolios

Derivatives are very useful and may be used in the implementation of the liability-hedging portfolio (LHP), either as an extra layer above cash instruments or as the main asset class.

What follows are examples of repo transactions used to adjust the duration of a bond portfolio. Repo operations are a means of raising additional cash in a portfolio; they make it possible to complement the asset profile with new investments. They may be used when government bonds in repos contribute to the targeted structure in terms of duration, cash-flow scheme, or earnings.

Some concrete examples using repos follow.

- Objective: to lengthen the duration when no cash is available. If the bonds available in the market are not long enough to reach the duration target, a second layer can be built with the help of repos. Using swaps to lengthen duration may be one solution. Using repos is an alternative, with the advantage of simplicity and the addition of the repo spread to the revenues. There is no need to provide efficiency tests, but there is less flexibility in maturity selection.
- Objective: to decrease convexity while keeping duration unchanged. This may be achieved by a combination of 1/ selling a long dated swap (i.e., fixed payer) and 2/ making repos a part of the bond portfolio with reinvestment of cash in intermediate maturities. Again an alternative to a full swaps solution.
- Objective: to be long both duration and credit (extension of the first example). The targeted structure may require a volume of assets greater than the balance sheet size, i.e., there may not be enough room for both government bonds (duration target) and corporate bonds (revenue target and/or liquidity target). Repos may be once again an alternative to swaps. Some documentation may be required to prove that the balance sheet is not at risk with leveraging. It makes sense to argue the following.
  1/ Government bonds present (almost) no credit risk but duration (AAA rating is better for that purpose).
  2/ A credit exposure is achievable without duration (short term instruments + CDS or duration-hedged corporate bond portfolio).

These two assets are orthogonal regarding duration and credit: there is no leverage here; the combination results in a synthetic credit bond with duration.

Of course, the usual reason to resort to repo transactions is to enhance the performance of a bond portfolio with limited additional risks by earning the repo spread when liquidity is not required of the bonds. When great demand for repos leads to wide spreads below short-term rates, one can reinvest the cash in short-term instruments whose redemption dates match those of the repos. If there is a certain volume of rolled repos, with a minimum amount stable over time, the cash may be pooled and invested on horizons longer than those of the repos. With more diversification it will be possible to earn a few basis points above the repo spread.
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Because the asset allocation may require leverage, one may choose to implement the LHP rather than the strategic asset allocation (SAA) with derivatives. Derivatives are preferred when a pension fund (bound by the prudent man rule) has a greater allowance for leverage than the asset management firm in charge of implementing the SAA.

Interest rates swaps are naturally suitable for cash-flow matching, which involves ensuring a perfect static match between the cash flows from the portfolio of assets and the commitments in the liabilities. So they are unlike exchange-traded futures contracts, which should be the instrument of choice for immunisation, which allows the residual interest rate risk created by the imperfect match between the assets and liabilities to be managed in a dynamic way.

Interest rate swaps may also be effective in modifying the cash-flow profile of the assets. For instance, in Northern European countries, after regulation of pension funds stiffened, many funds used swaps to lengthen the duration of their asset portfolios, mainly because the swap market for very long maturities is much deeper than that for government (and corporate) bonds. Inflation swaps, for example, can be used to manage inflation risk.

Inflation-linked bonds are clearly an appropriate match for the liabilities, as they give the lowest risk relative to the liabilities (just as nominal bonds offer the best replication of a series of fixed payments). However, investing heavily in cash instruments is not optimal from an ALM standpoint, because it gives away any expected return. As a consequence, one may initially focus on the definition of the SAA (for instance, buying a risky portfolio of straight bonds or investing in absolute return strategies) and use the swaps market to build the LHP, converting the SAA returns into the precise inflation-linked cash flows required to pay the projected liability payments. Pension funds will pay fixed flows (extracted from the SAA portfolio) and exchange them for inflation-linked cash flows tailored to meet the projected liabilities. This choice enables precise management of inflation risk.

We will now reconsider the previous stylised example involving a single liability cash flow equal to €55.76 million in real terms to be paid in 2028. At an assumed inflation rate of 2.5%, the expected nominal liability payment amounts to $55.76(1+2.5%)^20 = €91.37 million, i.e., an additional €35.61 million. The present value of this cash-flow payment in 2008 is equal to $34.44=(€55.76+€35.61)/((1+5%)^{20})$, assuming a 5% discount rate.

The core question in the design of a liability-hedging portfolio is how to immunise the present value to changes in inflation and interest rates (see figure 3.3).

To achieve perfect inflation and interest rate risk management, the pension fund enters into a swap with a nominal of €55.76m, for which it will make a single zero-coupon payment based on an assumed breakeven rate of 2.9% and will receive €55.76m* Inflation_Index (2028) / Inflation_Index (2008).

This assumption means that inflation would have to average more than 2.9% per year until the maturity of the bond.
3. Asset-Liability Management for Pension Funds

for the inflation-linked bond to do as well as the nominal bond of similar term. The 2.9% breakeven rate may be above the expectations of investors, since they may be willing to pay an inflation risk premium for protection of the principal. In 2028, the pension fund must pay $98.77 = 55.76 \times \left(1 + 2.9\%\right)^{20}$ million euros.

To make this payment, assuming, say, a 4.51% current zero-coupon yield on the twenty-year horizon, the pension fund buys $40.88 = 98.77 / \left(1 + 4.51\%\right)^{20}$ worth of a twenty-year zero-coupon bond (see figure 3.4).45

The cash-flow matching strategy for the pension fund therefore consists of holding a zero-coupon plus an inflation swap. It allows immunisation to changes in interest rates and inflation rates; the present value of future obligations is locked in.

45 - Risk-taking may involve tailoring and investing in an absolute return fund instead of in the zero-coupon bond.
Assume, for example, an unfavourable outcome, higher inflation rate (e.g., 3.5%) combined with a decrease in interest rates (e.g., from 4.5% to 4%), changes that together lead to a jump in the present value of liabilities. In 2008 the insurance company bought a zero-coupon bond, the new price of which is $45.08 = 98.77 \div ((1+4\%)^{20})$ on the assumption of a 4% discount rate. The marked-to-market value of the swap is then $5.56 = [55.76(1+3.5\%)]^{20} - [55.76(1+2.9\%)]^{20}$ on the 3.5% inflation assumption. Total asset value is therefore $45.08 + 5.56 = \varepsilon 50.64$ million. On the other hand, liability value is given by $50.64 = 55.76(1+3.5\%)^{20} \div (1+4\%)^{20}$. Hence, as can be seen in the figure below, the strategy leads to a perfect asset-liability match.

Figure 3.5: Immunisation of a real claim
A zero-coupon bond and an inflation swap together allow perfect replication of a real claim. The perfect asset-liability match is illustrated here, assuming lower inflation and an increase in interest rates. Unfavorable: Inflation increases to 3.5% a year and rates fall to 4%.

3.3.3. Non-linear exposures

Optional pay-offs

The examples we have considered so far involve only linear (even though stochastic) exposure to inflation and interest rate risks. An additional complexity in ALM for pension funds is the presence of non-linear risk exposure, such as that of a guaranteed annuity option (GAO). GAOs are minimum return guarantees in which the guarantee takes the form of the right to convert an assured sum into a life annuity at the better of the market rate prevailing at the time of conversion and a guaranteed rate. Many life insurance companies in the UK issued policies with GAOs in the 1970’s and 80’s, as part of an effort to replicate pension products which typically allow a certain fraction of the accumulated savings to be cashed in or paid out as an annuity. At the time—between 1975 and 1985—interest rates in the UK were above 10%. So, because these options were so far “out of the money”, offering GAOs with implicit guaranteed rates around 8% was considered harmless. But the fall of UK interest rates to well below 8% (currently rates are at 5%) has made the GAOs a significant risk factor in liability streams. In Europe, a common way to hedge for minimum interest rate guarantees is to use either receiver swaptions or floors on constant maturity swaps (CMS). Like standard interest rate floor contracts, a CMS floor consists of a strip of options known as floorlets. The CMS floor contract will specify the nominal amount, the strike, the maturity of the floor, the frequency of floorlets (i.e., annual, semi-annual, or quarterly), and the
3. Asset–Liability Management for Pension Funds

swap rate to use (e.g., the ten-year Euribor swap rate). For example, for a floor with a nominal of €150m, a strike of 4.75%, a ten-year maturity, and annual floorlets based on the ten-year swap rate, there will be ten floorlets with payments made annually. The payoff for each floorlet will be €150m x max(0, 4.75% - ten-year CMS rate), where the ten-year CMS rate is the ten-year EUR interest rate swap rate two days before payment.

For example, if the observed rate is 3.5%, the payoff will be €150m x (4.75% - 3.5%) = €1,875m (see Martellini et al. 2007 for more details on swaptions and CMS).

Inflation exposure on top of longevity risk
Although inflation swaps may be well suited to management of inflation risk, there are situations in which, because of uncertainty as to the size of the cash flows that require protection, their effectiveness is less clear. Overhedging strategies, as illustrated below, may then be used.

The inflation exposure of pensions in payment is random insofar as life expectancy is random. When life expectancy rises, of course, the amount to be paid out by pension funds rises as well; inflation exposure is likewise greater.

We will consider a very simplified model that takes into account underwriting risk. We assume that the real annuity, or un-inflated amount to be paid, which ultimately depends on actual mortality rates, is paid over one year, and follows a log-normal process, with a mean equal to -2% and volatility equal to 20%. For further simplification, the consumer price index is released with no delay. Inflation and the real annuity are assumed to be independent processes. The above drifts and volatilities are such that, on average, the consumer price index is 1 and the real annuity is 100. There is no interest rate, so both the discounted and undiscounted reserves are 100. We then calculate the 99% Value-at-Risk and the 99% Tail VaR (also known as Conditional VaR), given by the expected value above the 99th percentile. Thus, the Tail Value-at-Risk at the 99% probability for inflated annuity is 209 without any hedging strategy. This is to be compared with a Tail Value-at-Risk of 171 for the real annuity.46

Since the best estimate of the real annuity is 100, a “natural” hedge would consist of buying zero-coupon inflation swaps for a nominal amount (k) of 100. They will pay the consumer price index minus one in a year. With this swap transaction, the 99% Tail VaR is 176, which is 15% below the Tail VaR without hedging inflation exposure. This is still far above the Tail VaR for real annuity, because when people live longer, inflation exposure increases. In the tail of the distribution, inflation exposure is higher because the real annuity is higher. An exposure greater than that of the best estimate, achieved by greater exposure to inflation, can thus help diminish economic capital.

As stated in Rockafellar and Uryasev (2000), minimising Conditional VaR leads to more stable results than minimising VaR. We have chosen to minimise the risk on the annuities by finding the appropriate nominal of inflation swaps, where the

46 - The results come from 250,000 draws on each variable (Mersene-Twister generator).
3. Asset-Liability Management for Pension Funds

Risk is measured by the TVaR99% of the portfolio.

Minimising TVaR99% \((C \ast \text{inflation} - k \ast (\text{inflation}-1))\) gives a value of \(k=171\), and the solution is very close to TVaR(C). This is because TVaR(C) is the average exposure to inflation where \(C>VaR(C)\) because the two factors are independent. In our example there would be an analytical solution because the log-normal is tractable. However, numerical procedures generally need to be employed because TVaR(C) is not exactly the inflation exposure in the TVaR((C-TVaR(C) \ast \text{inflation} + TVaR(C)) zone. \(C>VaR99%(C)\) generally approximates but does not perfectly match \(((C-k_{opt}) \ast \text{inflation} + k_{opt}) > Var99%(C-k_{opt}) \ast \text{inflation} + k_{opt})\).

The optimum is fairly stable because the exposure to inflation is extremely low in the TVaR of the portfolio. In addition it remains fairly low even in the case of a moderate error of estimate. In our case, the Conditional VaR of our portfolio is between 171 and 172 for a hedge ratio between 140 and 180.

While bonds, futures and swaps transactions are key ingredients for the design of liability-hedging portfolios, other kinds of interest rate derivatives are also very useful in the management of liability risk when the presence of embedded options must be accounted for.

3.4. The Implementation of the LHP for Imperfectly Hedgeable Risks: Inflation, Wage-Indexed Liabilities and Longevity Risk

When risk factors are perfectly replicable, the main issue is the choice of instrument for the implementation of these portfolios.

In section 3.4.1, we focus on inflation risk and quote the work of Hoevenaars et al. (2005) as representative of the possibilities for replicating inflation with real assets. Allowing tracking error in the LHP, that is, using some of the strategic asset allocation’s risk budget in the LHP, opens the door to the use of additional asset classes. This possibility is especially useful when the LHP has a high cost, for instance, because the imbalance in the supply of and demand for inflation-linked securities may have led to a negative risk premium.

In section 3.4.2, we show that the conceptual distinction between hedgeable and non-hedgeable risk is fading with the development of the capital markets. Securitisation, for instance, makes it possible to transfer underwriting risk—traditionally considered non-hedgeable—to the financial markets. For the transfer of longevity risk, however, the main biometric risk for pension funds, solutions have yet to be found.

In section 3.4.3, we focus on wage-indexed cash flows, and argue that though there are no traded instruments that fully replicate this risk, they are best replicated by equities and other real assets. Because of the long-term relationship between equities and wages, the LHP for wage-indexed liabilities must contain equities.
3. Asset-Liability Management for Pension Funds

3.4.1. Managing inflation risk without inflation-linked securities

Inflation reduces the value of money over time, so even when not mandatory by law pension plans in general seek to index at least to inflation.

In an ALM framework, where liabilities are indexed to inflation, the natural risk-free security is the zero-coupon inflation bond of the adequate maturity, and the LHP is made up more generally of inflation-linked bonds and (zero-coupon or standard) inflation swaps.

The market for inflation-linked bonds is growing fast but is still a small fraction of total OECD pension assets: the global market capitalisation of sovereign inflation-linked bonds jumped 50% to $1.5 trillion in the two years through early 2008, according to Barclays Capital, but OECD pension assets amounted to $25 trillion in 2006.

It follows that the pension fund industry must consider alternative sources of inflation protection—if all liabilities were replicated by inflation-linked securities, a huge supply-demand imbalance would depress the real yield of these securities and ultimately give pensioners very poor returns.

Hoevenaars et al. (2005) discuss the replication of inflation exposure without inflation-linked bonds. The inflation-hedging properties of various assets are illustrated below.

The vertical axis shows the correlation and the horizontal axis the time over which it is measured. The horizontal scale is in quarters.

Figure 3.6: Inflation-hedging properties
Inflation-hedging properties of nominal assets for a buy and hold investor across different investment horizons (in quarters).
Working on quarterly US data ending in 2005, they find that the cash-account (the ninety-day T-bill) is the most correlated with inflation at all horizons; correlation reaches 0.97 at a seven-year horizon. They also find that commodities and inflation are highly correlated at all horizons. Commodities, after all, are consumed during production, and changes in their prices are one of the sources of inflation. The automatic impact of commodity prices on inflation probably accounts for their findings of a very stable inflation hedge quality (correlation of 30% for investment horizons longer than five years).

For real assets—equities, real estate, hedge funds, credit—correlation is negative over short horizons and becomes positive in the long run. Their findings may be explained by the "nominal illusion" phenomenon, as investors tend to discount real earnings at a nominal rate, as illustrated in the so-called Fed model (see section 3.2.b). In the Fed model, rising inflation, which means higher bond yields, results in lower short-term equity prices. Over a longer horizon, beyond a single business cycle, equities show that they are real assets and their prices catch up with general prices in the economy. Campbell and Shiller (1988), who identify two...
offsetting effects, make a similar argument. First, inflation increases the discount rate, which lowers stock prices. Second, inflation increases future dividend payments, which increases stock prices.

In the graph above, ten-year treasuries and credit have a positive correlation with inflation over time because the portfolio considered is a constant-maturity portfolio. On the other hand, Campbell and Viceira (2005) show that holding bonds to maturity is akin to accumulating inflation risk.

The construction of the LHP then depends on the investment horizon, here based on the liability horizon.

For a one-year horizon, Hoevenaars et al. (2005) find that the one-year LHP (built without inflation-linked securities) is—because they are hedges for inflation and real interest rate risk—made up largely of T-bills and bonds. For the inflation protection they offer, commodities account for a small fraction of the portfolio, but the investor will tend to short equities and other real assets because they have a short-term negative correlation with inflation.

Over long horizons the replicating portfolio is much more balanced, with a 25% share in equities and corporate bonds (credits) and the share in T-Bills reduced from 60% to 20%. Over long horizons, T-Bills lose their advantages over other asset classes for protection from inflation; they also become a risky real investment because of reinvestment risk.

3.4.2. Appendix: finance blurs the frontier between hedgeable and non-hedgeable items. Example with longevity risk

Introduction: on hedgeable and non-hedgeable risks

By definition, hedgeable risks are those that can be traded on deep and liquid markets. These risks are, in the main, financial risks, because interest rate exposure can be modified at any time by listed securities such as bond futures.

Non-hedgeable risks are those for which there is no market price. Underwriting (“actuarial”) risks are the main non-hedgeable risks, because each contract protects an individual as opposed to a commodity. These risks must generally be located in the balance sheet of regulated entities (insurance companies, pension funds).

The distinction between hedgeable and non-hedgeable is of great importance in many fields:

- New accounting standards are gradually making a distinction between hedgeable and non-hedgeable risk, with hedgeable risks valued at market value and non-hedgeable risk at best estimate (expected value) plus a market value margin that compensates for the uncertainty relative to the price at which the risk may be exchanged.
- In ALM and risk management, the main distinction is that exposure to hedgeable risks can be modified at any moment in a very flexible manner, whereas non-hedgeable risk cannot be managed at high frequency. For instance, in the formal ALM model presented in this study, it is assumed that non-hedgeable risks cannot be managed at all.
In practice, however, the distinction between hedgeable and non-hedgeable risks is not always as clear:

- Many actuarial risks can be partly reinsured, usually on a yearly basis. In this case, however, once the reinsurance decisions have been made, these risks are non-hedgeable for one year.
- Some risks are partly hedgeable.
  - Equities, for instance, are, despite significant short-term volatility, the best long-term hedge for wage-indexed liabilities.
  - Because inflation-linked securities are issued in only a few countries, institutions in other countries are subject to basis risk when they buy inflation protection—a Dutch or Swiss pension fund that hedges its local inflation risk with French or European inflation-linked bonds is imperfectly protected because the rates of inflation in the Netherlands or in Switzerland may differ from those in France or in Europe as a whole.
  - Very long-term nominal and real bonds are often in short supply, so not even interest rate risk can be perfectly hedged on deep, liquid, and transparent markets. The principal non-hedgeable risk for pension funds is longevity risk, as improvements in life expectancy increase the amount paid out in annuities. Invalidity and incapacity protection may also be provided by some pension funds, but in a less extensive manner when considered on an aggregate basis.

In the current section, we will recall that, although it is needed, the capacity to transfer longevity risk is currently limited. Capital markets could be a natural provider of capacity, with an ever-expanding number of balance-sheet risks being securitised over the years. However, most of the risks securitised are short-term rather than long-term. We will take a brief look at the difficulty of transferring long-term risk.

A need to manage longevity risk

Even though underwriting risks are inherited in the normal course of running a pension fund, these risks must somehow be transferred and managed. Longevity risk may be transferred for the sake of employees and employers. When longevity risk is borne mainly by employees, as in the Netherlands, where low plan returns lead to lower pension because of lower indexation, hedging longevity risk benefits employees, as it allows them to enjoy annuities that will not be reduced in the event of increased longevity. In countries or pension funds where longevity risk is borne by the sponsor, longevity risk present in the balance sheet is a significant source of risk and, as such, burns up a significant portion of available capital. It may thus limit the ability of pension funds to take other risks, because when everything, including risk, is valued at market value, the sum of risks taken shall not be greater than available capital; in other words, it shall not be greater than the surplus.

Hedging this risk also makes it possible to save risk-capital (and regulatory capital in countries where such risk-sensitive regulations as the FTK are in force). Studies such as that done for the UK by the Institute of Chartered Accountants (ICAS) estimate that the 99.5% VaR in longevity risk is that of a permanent drop in mortality rates of approximately 25%. This estimate is consistent with the capital charge for longevity risks for insurance companies under QIS3. This assumption increases the cost of providing annuities to the...
average seventy-year-old pensioner by approximately 15%.

The ability to transfer underwriting risk is thus welcome on a structural basis, as transferring risk is equivalent to borrowing risk capital; in addition, the ability to manage risk dynamically makes ALM more flexible—as illustrated in chapter III, ALM without non-hedgeable risk boils down to standard asset management.

**Limited capacity for the transfer of longevity risk**

The three main channels that can be used to transfer longevity risk are:

- Reinsurance (the protection-seeker takes insurance from reinsurers)
- Conversion of defined benefits to annuities via bulk "buy-outs" (pension liabilities are transferred directly to insurance companies, together with backing assets)
- Pension fund purchases of insurance products to balance annuities (imperfect replication)

These channels ultimately rely on the combined capacity of the insurance and reinsurance markets to absorb these risks, and there is ample evidence that this capacity is limited. Insurance and reinsurance companies account for the bulk of the market for longevity risks, usually an over-the-counter market; this market is still in the hands of very few insurance companies.

Capacity is limited, after all, because insurance companies are able to offset only some longevity risk by pooling it with the mortality risk protection they offer in conventional contracts and mortgage insurance. Insurance companies have great incentives to take on a limited amount of longevity risk from pension funds, but beyond a certain threshold diversification benefits diminish and transfer prices must rise.51

However, mortality risk does not fully offset longevity risk because it has a very different nature. Mortality risk is in essence a short-term risk, with a specific catastrophe component, such as wars, terrorism, or pandemics such as the bird flu. A sudden rise in mortality rates is possible and would severely affect providers of life insurance. Longevity risk, by contrast, is a long-term trend risk. After all, barring discovery of the fountain of youth, the notion of catastrophe for longevity risk is inconceivable.

Beyond diversification benefits and the transfer to reinsurers that would apply the same logic, third parties are needed to transfer these risks.

**Capital market for insurance risks**

The trend in recent decades has been to use two major instruments—securitisation and "parametric" insurance bonds—to transfer risks to the capital markets.

**Securitisation**

Securitisation involves pooling assets and/or liabilities and turning them into tradable financial securities. Protection is provided either against the entire risk of a book or against catastrophic risk. With mortality risk, for instance, insurers and reinsurers may seek protection from deterioration in mortality rates or from the possibility of catastrophic mortality, i.e., a pandemic that would affect their portfolios. In effect, investors are buying an insurance-linked bond and providing capital to insurers and reinsurers in the form of the principal. Much as with corporate bonds, investors

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50 - Transactions are negotiated case-by-case with protection providers rather than with standard exchange-traded instruments.

51 - The reader will note that pension funds too could diversify away some of their longevity risk by accepting some of the mortality risk from insurance companies, swapping some longevity for some mortality risk, or buying mortality risk from the capital markets, as mortality bonds are regularly issued, as illustrated below.
will get enhanced returns if the underlying book is profitable, but not (in terms of both coupon and principal) in the event of losses. Coupons may be financed out of future premiums (as is usual with life insurance mortality bonds) or out of existing assets (as is usual with P&C bonds).

Securitisation can naturally involve splitting the risk into tranches, as with the Axa motor securitisation in 2005. As illustrated below, AXA France P&C reinsured its motor portfolio and the external reinsurer securitised motor premiums and associated risk in the form of tranches, each characterised by attachment and detachment points defined in terms of loss ratio, as shown in the second illustration below. AXA bought the equity tranche; as a consequence, a rise in claims first affects AXA’s book up to the value of the equity tranche, then investors are hit.

For securitisation to be effective, sophisticated information systems are required, because claims need to be perfectly auditable or certified by an independent party. Moreover, the transaction must often be rated, so once again clear access to data and models may be necessary.

Parametric insurance bonds
The alternative to securitisation is to create a market for a given class of risk. Such markets have been created with parametric insurance bonds, as well as futures and options (the CBOT introduced futures and options for insurance against such catastrophes as hurricanes).

For “parametric” CAT bonds, the reasoning is similar to that for catastrophe (CAT) bond issues from securitisation operations, but the trigger is a defined level of an industry index representative of industry-wide losses or of a parametric index such as the number of hurricanes during a season.
Impact of Regulations on the ALM of European Pension Funds - January 2009

3. Asset-Liability Management for Pension Funds

A Dutch pension fund with exposure to the longevity of Dutch citizens of both sexes would experience great basis risk when relying on such a bond for protection.

However, listed instruments such as parametric insurance bonds provide additional flexibility because market participants can modify their exposure by buying or selling some of the listed instruments. Listed futures offer the greatest flexibility, as they allow quick adjustment of the position on the underlying risk factor. When there is a deep and liquid market for insurance risks, they can then be managed like a portfolio of assets—exposures can be optimally diversified depending on market conditions.

**Capital markets for longevity risk have yet to be developed**

Capital markets may serve both to increase the flexibility and the overall capacity for longevity risks. After all, beyond the limited capacity from insurance and reinsurance companies, the capital markets are the ultimate resource.

However, while short-term risks have been transferred with increasing success in recent years, long-term risks are another matter altogether.

The transfer of mortality risk has grown significantly, with mortality bonds and mortality CAT bonds, as well as mortality swaps and derivatives. Extreme mortality risks, for instance, were successfully transferred in Swiss Re Vita, the first mortality bond, issued in 1993 by Swiss Re—the issue was fully subscribed at $400 million, offering investors coupons of quarterly US dollar LIBOR + 135 basis points. Standard and Poors rated the deal

times their average wind speed, not the actual losses in the sponsor’s account. These insured parametric indices may be refined so as to approximate the losses borne by the industry, in which case they are referred to as “modelled loss” triggers.

For the investor, the advantage of these external indices is their transparency: the protection-seeker cannot use “creative accounting” to influence the amount of losses transferred from its books to those of the investors.

When issuing parametric bonds, the protection-seeker must balance the advantages of transparency and the basis risk that is retained. Transparency also benefits the issuer, because it is easier to find investors, and because issuance costs are reduced—as indices or triggers are provided externally there is no need to audit the systems and models, and the cost of rating such securities is also diminished because of their commodity nature.

On the other hand, the issuer retains basis risk because the exposure of its own book is always imperfectly correlated with external indices. For instance, not only are mortality rates within a particular book imperfectly correlated with those of the population as a whole (the natural reference for parametric mortality bonds), but also the age structure of the insured may differ from that of the population as a whole and, last, the actual amount of risk depends on the sums insured and on how they are attached to each age layer. When it comes to the listing or issuing of emerging risks, basis risk may be even greater. For instance, the European Investment Bank (EIB) and BNP Paribas (BNP) tried to launch a survivor bond linked to the survivor index of British men.

A Dutch pension fund with exposure to the longevity of Dutch citizens of both sexes would experience great basis risk when relying on such a bond for protection.

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3. Asset-Liability Management for Pension Funds

A+ and Moody’s A3. The 2003 Vita Capital was followed by Vita Capital II in April 2005 ($365 million) and Vita Capital III in January 2007 ($705 million).

Longevity has not had similar success; for the moment the most well known attempt is the EIB/BNP longevity bond. In 2004, EIB and BNP planned to issue a twenty-five-year longevity bond designed to offer annuity providers protection from longevity risk. It is often argued\(^\text{53}\) that, in addition to the premature nature of the bond and the lack of recognition of longevity risks even among pension funds and insurance companies, one of the reasons for its failure was that it was based on a longevity index of a cohort of English- and Welshmen aged sixty-five in 2003, and hence provided but a partial hedge even for UK institutional.

Long-term risks may be difficult to transfer for structural reasons. For instance, there may be cost issues. When risk transfer and capital transfer are compared, it is clear that the cost of transferring risks depends on the duration of these risks. If it is assumed that the cost of capital is 6% above the risk-free rate, as an approximation of the cost of risk-capital raised by a BBB institution,\(^\text{54}\) the cost of transferring a risk can be approximated by multiplying its duration by 6%. In other words, for durations longer than fifteen years, borrowing the risk capital from financial markets to cover long-term risks costs more than the risk-capital itself, so transferring these risks may add no capital resource to the balance sheet of the ceding company (!).

Another source of difficulty is that most traditional investors do not invest for as long as pension funds do. With only a limited portion of their books open to the long term, the call should be for spreading the risk among multiple institutional investors rather than among a small number of buyers. Another possibility is to try to transfer these risks to those that usually benefit from increases in longevity, such as pharmaceuticals, health care providers, and retirement institutions, as longevity risk is a protection for these sectors—even though they have not been natural buyers of insurance risks in the past.

It should also be kept in mind that the financial markets have an appetite for securitisation of insurance risks, because they provide for good diversification benefits. Recent history has shown that, in comparison with spreads on corporate bonds and other securitisations, the spreads on insurance-linked securities have held up relatively well during periods of turbulence.

Can we conclude that it is only a matter of time before longevity risk is actually passed through to capital markets?

3.4.3. The use of equities for hedging of wage-indexed liabilities

Though interest rate and inflation risk are the most frequently described risk factors in finance textbooks, uncertainty as to future wage levels is an additional source of risk. After all, in conventional last-wage pension plans, pension benefits are based on wages. Although many last-wage pension funds in the UK have closed, some of the large multi-employer pension funds that did not take contribution holidays during good times are still open, and many more are closed to new members but remain available to participants. More broadly, the last wage earned by an employee...
determined his pension benefits, and using average or last wages to determine pension benefits is still common in many countries. In addition, the long-term target of many hybrid DB pension plans is to index paid pensions and accumulated savings to wages. In the Netherlands, for instance, where indexing is now conditional rather than formally guaranteed, assets are often allocated in such a way as to reach the explicit target of indexing benefits to wages; it is long-term goals, not unconditional promises, that shape asset allocation.

In the short term, wage policy may be considered discretionary as employers may keep overall compensation down in bad times. Over the long run, though, it is all about macro-economics, as wages for a given qualification and experience are closely tied to the broader job market and are beyond the control of any single employer. So, as part of any liability-hedging exercise, pension plans must seek the assets most highly correlated with long-term wage movements.

In 3.4.3.1, we examine the reasons why equities and wages move in tandem over the long run, i.e., why they are co-integrated. In 3.4.3.2, we use a simplified model of the long-term relationship between wages and stock prices and of their short-term dynamics, and use it to compute the portfolio that best replicates wage-indexed liabilities for each time horizon. This stylisation provides insight into the evolution of the LHP for wage-indexed liabilities, but it is not a portfolio construction exercise.

**3.4.3.1. Beyond the business cycle, wages and profits have a stable long-term relationship**

Figures 3.8 and 3.9: Wages and equities are co-integrated

Graphic and statistical analyses show that wages and stock prices are co-integrated — they exhibit a strong dependence over the long run.
3. Asset-Liability Management for Pension Funds

Graphically, wages and equities exhibit a one-to-one relationship. As regression involving trended series runs the risk of being spurious, one generally tests for co-integration. This generally involves two steps, first testing for a unit root in each variable, then for stationary linear combinations of variables. Below, we use Gretl\textsuperscript{55} statistical package to do the standard co-integration analysis on our two variables. The results are conclusive: not only are they co-integrated, but the long-term relationship is also one-to-one.

**Box: Co-integration test of stock prices and wages**

**Step 1: testing for a unit root in wages**

Augmented Dickey-Fuller test, order 2, for wages. Sample size 76
unit-root null hypothesis: $a = 1$, test with constant
estimated value of $(a - 1)$: -0.00279813
test statistic: $\tau_c(1) = -0.742682$
asymptotic p-value 0.8342

**Step 2: testing for a unit root in sp**

Augmented Dickey-Fuller test, order 2, for sp. Sample size 76
unit-root null hypothesis: $a = 1$, test with constant
estimated value of $(a - 1)$: 0.00509036
test statistic: $\tau_c(1) = -0.742682$
asymptotic p-value 0.9837
3. Asset-Liability Management for Pension Funds

The rationale for this co-integration of wages and equities is explained below. It involves assessing the relationship between wages and earnings, then that between earnings and stock prices.

Beyond the current business cycle, wages and earnings are a constant share of GDP
The driving forces behind wages are traditionally considered from either a micro- or a macroeconomic standpoint. From a microeconomic standpoint, wages are usually measured in units of output and are hence directly linked to the economy. From a macroeconomic standpoint, supply and demand in the labour market are the driving force of wages in a business cycle. Over the long run, the link to the economy is predominant, as in microeconomic theory.

Real wages and real profit are driven by productivity growth
In most models long-term prospects are driven mainly by productivity and prices. So it is to be expected that productivity growth will be the main driver of real wages and real GDP—flation-adjusted variables of interest. Inflation is important in the business-cycle analysis because it interacts over the short run with other variables. For instance, the determinants of wages may be inflation, the unemployment rate (the difference between the actual and the structural unemployment rates measures the supply of labour for Phillips 1958), and productivity growth.

Step 3: co-integrating regression
Co-integrating regression - OLS estimates using the 79 observations 1929-2007
Dependent variable: wages

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COEFFICIENT</th>
<th>STDERROR</th>
<th>T STAT</th>
<th>P-VALUE</th>
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</thead>
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<td>sp</td>
<td>1.01675</td>
<td>0.0312209</td>
<td>32.566</td>
<td>&lt;0.00001 ***</td>
</tr>
</tbody>
</table>

Unadjusted R-squared = 0.932311
Adjusted R-squared = 0.931432
Durbin-Watson statistic = 0.128222
First-order autocorrelation coeff. = 0.897751
Akaike information criterion (AIC) = 93.2254
Schwarz Bayesian criterion (BIC) = 97.9643
Hannan-Quinn criterion (HQC) = 95.124

Step 4: Dickey-Fuller test on residuals
lag order 2, sample size 76. Unit-root null hypothesis: a = 1
estimated value of (a - 1): -0.0933622
test statistic: tau_c(2) = -2.16842
asymptotic p-value 0.4399
P-values based on MacKinnon (JAE, 1996)

There is evidence for a co-integrating relationship if:
(a) The unit-root hypothesis is not rejected for the individual variables.
(b) The unit-root hypothesis is rejected for the residuals (uhat) from the co-integrating regression.
3. Asset-Liability Management for Pension Funds

Is there a long-term equilibrium?
In addition to the expected fluctuations in the business cycle, it is worth assessing the stability of the long-term relationship between wages and GDP, and hence between wages and profits.

Equilibrium theories, such as neo-classical theory of the 1950’s and 60’s, postulate that economies tend toward a long-term equilibrium where the intensity and remuneration of capital and labour are stable, wages are a stable share of value-added.

Disequilibrium theories of the 1980’s, on the other hand, insist that rigidities can lead to persistent deviation from equilibrium or to a distinct equilibrium. For instance, the equilibrium unemployment rate can shift higher (because of rigidities in the labour market), or the share of capital in GDP can rise at the expense of that of labour. Other sources of structural changes may include globalisation or changes in remuneration practices (where employees are also stockholders, as is common in the US, the employee-stockholder balances his employee preference for higher wages and his stockholder preference for higher profits).

Wages and profits have a stable long-term relationship.
For the US as a whole, the share of labour in value added has proved remarkably stable when measured in unit labour costs, and so has the share of profit. Unit labour costs (below) also show a very stable share of labour in value added.

Unlike wages, which are very stable as a percentage of corporate GDP, after-tax profits are quite volatile. After all, profits are not only a relatively small share of GDP, but can also be considered a residual, as they are what is left from sales after wages and other expenses have been paid. Consider the following illustration: wages represent 65% of GDP, and profits 6%. As a consequence, a one-point increase in the share of wages

Figure 3.10: Share of wages and profit in value added
The remuneration of production factors proves remarkably stable over time.
and a one-point fall in the share of profits in GDP translate into a 1.5% increase in wages and a 16% fall in profits. Though profits and wages are expected to move one-to-one over the long term, as they are driven by productivity and prices, profits are far more volatile than wages over the short term. During the recession starting in 1929, profits became a negative fraction of GDP.

b) Stock valuations are based on earnings
The Fed model or simply the PE ratio?
One of the most popular models for the valuation of the stock market is misleadingly called the Fed model by its proponents, on the grounds that it was used by the Federal Reserve in one of its publications; this model compares the earnings yield (expected forward earnings divided by the market price) and the long-term bond yield (generally the ten-year American Treasury note) to determine whether markets are over- or under-priced. As a rule, markets are cheap when the expected earnings yield is higher than that of the ten-year note and expensive when it is lower.

The data used as evidence for the validity of this model are usually post-1995; before 1995, after all, there was no such relationship between expected earnings yield and long-term bond yields.

A well known competing model is that of Robert J. Shiller, who in 2000, just before the burst of the bubble, published his *Irrational Exuberance*. In this book, Shiller argues that the price/earnings ratio (P/E) is the best valuation indicator of the stock market over the long run, because this ratio, composed as it is of two nominal figures (expressed in current dollars), is a real measure of value and cannot be benchmarked against a nominal measure such as the nominal ten-year bond yield.

In Shiller’s graph (below), the negative relationship between the P/E ratio and the ten-year bond yield has held since 1975, as spikes in inflation coincided with
3. Asset-Liability Management for Pension Funds

Figure 3.12: Stock valuations
Shiller (2000) argues that, ultimately, stock valuations are a constant multiple of earnings. Common models involve a dependency between price-earnings ratios and bond yields.

falling stock prices and falling inflation accompanied the huge rally of the 1990’s. He argues that it is the result of a phenomenon he calls money illusion and of Federal Reserve efforts to tame inflation at the expense of more pessimistic prospects for growth, which naturally lower stock prices, as diminished growth prospects “g” lead to a lower price “P”.

When it is assumed that Shiller’s model is valid, the P/E ratio is stationary. With the Fed model, the P/E ratio is stationary as long as the nominal rates themselves are stationary.

c) On the quality of the co-integration estimate
When long-term (labour) wages and (capital) earnings are a stable share of value added (GDP) and the P/E ratio is stable, stock prices and wages will be co-integrated. Structural breaks are possible—for instance, changes in the share of labour and capital in GDP, or stationary as opposed to constant stock price valuation: wages/earnings (W/E) and P/E have no long-term averages; they fluctuate within bounds. Then the wages/price (W/P) ratio has no long-term average, either; it fluctuates within certain bounds as well, and the correlation of wages and prices falls. But the fundamental long-term links between equity and wages have not been broken.

3.4.3.2. The replication of wages as a function of the time horizon
Because of their long-term link to the economy, equities would seem to be a good hedge for wage-indexed liabilities: equities are the risk-free investment for the ALM investor with very long-dated wage liabilities. However, these two “assets” are of different natures, a circumstance that needs to be taken into account in the construction of the replicating portfolio: the LHP must be adjusted for the investment horizon, as our stylised model shows.
3. Asset-Liability Management for Pension Funds

Although the investment horizon may be that of the liability, it may also be dictated by the regulator or other internal constraints. For instance, it may be the horizon over which the sponsor’s management is judged, generally much shorter than the duration of the pension fund’s liability.

An additional property is that the risk-free long-term strategy exhibits high volatility over the short term. On the other hand, strategies that are risk-free over the short term exhibit very high volatility over the long term, as shown in section 4.1.

The model
Although in our stylised model the long-term relationship between stocks and wages is accurately described by our 1929-2007 regression, the short-term dynamics have been simplified for tractability; as a consequence the model is illustrative of the strategies that must be used, and of the rules to be implemented in asset allocation.60

Our model involves a special-case Engle and Granger analysis. Because it involves two steps, it does not fall into the category of vector error co-integration models (VECMs):

- The first step involves using least square analysis to estimate the long-term relationship between wages and stock prices, as in the previous section, where the long-term relationship between wages and equities is one. After rebasing wages, the co-integration relationship reads:

\[ w - sp = 0 \]

- The second step is the estimation of the short-term relationship. In 3.2.b we find that wages and the residual from co-integration have very poor predictive power on stock prices. This finding is consistent with the view that whereas stock prices are a leading indicator of the economy, therefore helping predict GDP and wages, wages are a lagging indicator of the business cycle and do not help forecast equity prices. This view is consistent with the OECD’s definition of leading and lagging indicators, as well as with the fact that wages have not been used in the literature to predict stock prices.

59 - “Wage and salary disbursements” index as published by the Bureau of Economic Analysis.

60 - In addition, the wage index chosen is a national index of paid wages, but in the Netherlands industry-wide negotiated base wages are often used as a reference for indexing purposes. Although national wages are more generic data for such a study, in implementation additional specific data must be taken into account.
Our solution is based on the forward-iteration of the following stylised model:
\[
dw_{t+1} = \alpha \cdot (w_t - sp_t) + \beta \cdot dspt_{t+1} + \epsilon_{t+1},
\]
where \( w \) represents the (logarithm of the) wage-index and \( sp \) the (logarithm of the) S\&P500.

The following coefficients are used in the illustrations:
\( \alpha = -0.05 \), i.e., the duration of the mean reversion is twenty years. In other words, reverting to equilibrium would take twenty years, approximately five business cycles. So the effects of a single business cycle (e.g., high asset prices relative to the state of the economy) are visible for as much as another twelve years or so.

\( \alpha = 0.12 \), i.e., 12% of the change in the S\&P500 price index reflects the combined change in prices and productivity, passed through to employees in the form of higher wages. 88% of the change in the stock market is attributable to other factors—valuations and expectations—that do not have an immediate effect on wages. Whereas the co-integration relationship ensures that expectations with perfect foresight will progressively pass through to wages, pure volatility (imperfect foresight) cancels out over time.

The standard deviation of the forecast error on wages is \( \sigma(\epsilon) = 3\% \). It may seem excessive, but the forecast error on wages rises when one includes the 1929 recession as well as those of the 1980’s.

We assume that the standard deviation of the forecast error on equities is \( \sigma(\upsilon) = 15\% \), in line with implied volatility prices.

Geometrically, the LHP consists of the projection of the liabilities on the tradable securities. Interestingly, in our case, financial risk is shed by taking on dynamic exposure to the financial markets.

Geometrically, the LHP consists of the projection of the liabilities on the tradable securities. Interestingly, in our case, financial risk is shed by taking on dynamic exposure to the financial markets.

Forward iteration of the model leads to an analytical solution for the forward wage growth as well as its forecast error.

Buy and hold equity investor
\[
dsp_t - dw_t = -\sum_{i=1}^{t} \alpha \cdot (1 + \alpha)^{t-i} \cdot ((\beta - 1) \cdot \upsilon_i + \epsilon_i) - ((\beta - 1) \cdot \upsilon_i + \epsilon_i) = \sum_{i=1}^{t} \alpha \cdot (1 + \alpha)^{t-i} \cdot \eta_i + \eta_t
\]
with \( \eta_i = -((\beta - 1) \cdot \upsilon_i - \epsilon_i) \) \( i=1 \) to \( t \)

For each future time period \( t \), formula (a) shows the forecast error of the portfolio composed of the wage-indexed portfolio and of equities on the asset side. It represents the forecast error of the surplus of a pension fund that invests in equities in a static way to match its wage-indexed liability.

The forecast error in the cumulative holding return for a pension fund fully invested in equities reads:
\[
R_t (sp - w) = \sum_{i=1}^{t} \left( \sum_{i=1}^{k} \alpha \cdot (1 + \alpha)^{t-i} \cdot \eta_i + \eta_t \right)
\]
with \( \eta_i = -((\beta - 1) \cdot \upsilon_i - \epsilon_i) \)

Replicating portfolio (projection of wages on equities)
From (a), we derive (b): the forecast error of future increases in wages is linked to the error term in wage growth (\( \epsilon_i \) as well as to the random component in stock prices (\( \upsilon_i \)) at each future period of time.
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\[
dw_t = \sum_{j=1}^{T-1} \alpha \cdot (1 + \alpha)^{t-1-j} \cdot ((\beta - 1) \cdot v_j + \varepsilon_j) \cdot (\beta \cdot v_j + \varepsilon_j)
\]

The forecast error in the cumulative increase in wages between \(t=0\) and \(T\) follows:

\[
w_t - w_0 = -\sum_{j=1}^{T-1} \left( \sum_{k=1}^{j} \alpha \cdot (1 + \alpha)^{k-1-j} \cdot \eta_k \right) + \sum_{k=1}^{T} v_k
\]

with \(\eta = -((\beta - 1) \cdot v_j - \varepsilon_j)\) and \(\eta = -\sum_{k=1}^{j} (\beta \cdot v_k + \varepsilon_k)\)

\[
w_t - w_0 = -\sum_{j=1}^{T-1} \sum_{k=1}^{j} \alpha \cdot (1 + \alpha)^{k-1-j} \cdot ((\beta - 1) \cdot v_j + \varepsilon_j) + \sum_{k=1}^{T} (\beta \cdot v_k + \varepsilon_k)
\]

From the exposure to forecast error in stock market returns and to the uncorrelated forecast error in single period wage growth, it is easy to derive the LHP for a wage-indexed liability.

The LHP reads:

\[
w_t - w_0 |(v_j, i \leq T) = \sum_{j=1}^{T} \sum_{k=1}^{j} \alpha \cdot (1 + \alpha)^{k-1-j} \cdot (\beta - 1) \cdot v_j + \sum_{k=1}^{T} \beta \cdot v_k a
\]

Interestingly, the LHP, understood as the projection of the liability growth over the sub-space of traded securities, is neither a buy-and-hold nor a fixed-mix portfolio but a time-dependent portfolio with weights at time \(j\) of \(w_{LHP,j}\), the rest of the investment consisting of risk-free ALM securities over the horizon of the investment, i.e., zero-coupon bonds maturing at the same time as the liabilities in \(T\).

The exposure to each future unexpected return \(v_j\) is achieved by equity holdings at time \(j-1\leq T-1\) of:

At \(t=0\), the strategy involves holding a proportion of equities (relative to the accrued wage-indexed liability) equal to:

\[
w_{LHP,\{0,1\}} = -((1 + \alpha + (1 + \alpha)^T) \cdot (\beta - 1) + \beta
\]

The equity holdings of the LHP progressively diminish toward \(w_{LHP,\{T-1, T\}} = \beta\), which is the short-term LHP.

For very long-term maturities, the LHP starts with (almost) full investment in equities.

Over the long term, after all, equities and wages are perfectly correlated, with coefficient one. However, as time passes and equity returns have gradually passed through to wages, the subsequent effects of equity returns are diminished. When the time horizon is of one year, the resulting effect of past equity increases is perfectly predictable, and only the one-year ahead change in equity returns will pass through to wages by proportion \(\beta\), so \(w_{LHP,\{T-1, T\}} = \beta\).

---

61 - For simplification, dividend payments are not taken into account in the formula. When one assumes a constant dividend to price ratio, all equity weights in current formulas are simply adjusted downwards by the dividend ratio.
3. Asset-Liability Management for Pension Funds

The LHP naturally minimises the variance of the pension fund over the time horizon considered. The variance reduces to:

\[
\text{VAR}(\text{LHP} - L) = \sum_{i=1}^{T} \sum_{k=1}^{i-1} \alpha^2 \cdot (1 + \alpha)^{2(k-i-1)} \cdot \sigma^2(e_k) + \sum_{i=1}^{T} \sigma^2(e_i)
\]

\[
= (T + \sum_{i=1}^{T} \sum_{k=1}^{i-1} \alpha^2 \cdot (1 + \alpha)^{2(k-i-1)}) \cdot \sigma^2(e_i)
\]

This version of the LHP is more efficient than the static version (SLHP), which would consist of the average exposure to the stock market, i.e., a fixed weight of

\[
w_{\text{SLPH}} = \sqrt{\sum_{i=1}^{T} \sum_{k=1}^{i-1} \alpha^2 \cdot (1 + \alpha)^{2(k-i-1)} \cdot (\beta - 1)^2 + k \cdot \beta^2}
\]

Regardless of the investment horizon, it is more efficient than full static investment in equities.

Figure 3.13: Equity exposure of wages
One sees for different maturities of the wage-indexed liability how the LHP exposure to equities varies over time. As the term to maturity increases, exposure to equities increases as well.

Figure 3.14 illustrates the annual volatility of a pension fund that uses different strategies up to the maturity of the liability.
3. Asset-Liability Management for Pension Funds

Figure 3.14: Annualised volatility of a pension fund by strategy
The X-axis shows the maturity of the liability, that is, the annual volatility shown is the observed volatility of the pension fund when the liability and the investment strategy mature together, but it is not a time-series analysis. The blue curve—full investment of premiums in equities—is far from optimal for liabilities with short maturities, because the pension will amass very high volatility. The black dotted curve, still buy and hold investment in equities, but with the optimal average weight, is a far better strategy. However, the red curve, time-dependent exposure to equities, is far better. For long horizons it allows the annualised volatility of the pension fund to fall to very low levels.

The differences between these two portfolios are also reviewed below:

Figure 3.15: Replicating equity weights for various maturities
Whereas in the static LHP (SLHP, dotted black line) the pension fund holds the "average" exposure of wages to equities, in the time-dependent LHP the pension fund holds exactly the amount of equities needed at each time period. For a given maturity chosen on the X-axis, the pension fund starts in year one at the red curve, always higher than the black curve representing the static replicating strategy. Equity holdings are reduced once returns have been passed through to wages: in year ten of a fifteen-year maturity, for instance, the equity holdings of a time-dependent LHP are much lower than those of a static LHP.
3. Asset-Liability Management for Pension Funds

Conclusion on risk management techniques
From both accounting and regulatory perspectives, the use of advanced risk management techniques is strongly recommended. After all, IAS 19 requires the transfer of any pension fund loss outside the 10% “corridor” to the balance sheet of the sponsor. FRS 17, by which these losses are fully and immediately recognised in sponsor’s P&L rather than linearly amortised over time, as in IAS 19, exacerbates the problem.

From a regulatory perspective, breaching a minimum floor implies costs. In flexible regimes such as the UK, costs arise primarily from rising insurance protection costs (the PPF levy). In more restrictive jurisdictions such as the Netherlands, shortfalls must be remedied quickly, requiring immediate cash injections from the sponsor.

The techniques presented here, based on risk diversification or risk hedging, are at the core of some of the most spectacular recent advances in portfolio theory.

In this section, we have argued that the LDI approach to asset-liability management is consistent with a “separation theorem” that argues that the objectives of risk management and performance generation are best dealt with separately. On the one hand, the pension fund is to design an LHP based on cash instruments, or derivatives for better customisation of the strategy. On the other hand, performance generation can be dealt with in the traditional context of asset management, with an enhanced focus on risk management justifying the use of such sophisticated techniques for risk diversification or risk hedging (with or without derivatives).
4. Prudential and Accounting Constraints on Pension Fund ALM
4. Prudential and Accounting Constraints on Pension Fund ALM

Introduction
Regulations may be preventive or punitive, but in all cases they are prescriptive and must be taken into account in the design of the investment strategy of regulated entities.

Punitive regulations usually involve ex-post extra costs when the funding ratio of pension plans deviates from implied equilibrium. IAS 19, which mandates the recognition of any pension plan surplus or deficit greater than 10% in the P&L of the sponsor, may be considered punitive.

Preventive regulations are meant to ensure prudence in the risk management of a pension fund. Risk-based bodies of regulation such as the Dutch FTK, which requires risk-buffers, are preventive. European regulations are increasingly becoming risk-based.

From a conceptual standpoint, “risk-based regulations”, regulations that require additional funding for risk-taking, are currently favoured by regulatory bodies—recent examples include the Basel II accord (though not fully risk-based) and Solvency II.

Binsbergen and Brandt (2008) show that risk-based regulations, stylised as a Value-at-Risk constraint, greatly improve the efficiency of investment strategies used by naive or myopic investors, making dynamic optimisation less necessary. The investment strategy resulting from adherence to VaR constraints is indeed very close to modern ALM techniques, involving a dynamic exposure to the performance-seeking portfolio (PSP) and the liability-hedging portfolio (LHP).

The LHP is the investment strategy that best replicates the liability value, as reviewed in greater detail in chapter 3 of this study. From a theoretical standpoint, these expected benefits are in keeping with the emphasis in the insurance industry on the expected benefits of aligning required regulatory and economic capital.

Actual regulations involve biases and a deviation from this theoretical setting. There are two categories of bias:
1. Regulations are prescriptive, and their prescriptions are often biased. Prescriptions may involve either the valuation of liabilities or the measure of risk.
2. The horizon for risk measurement tends to be short, whereas pension funds are very long-term investors. Pension funds, after all, are not commercial entities, so in general they cannot go bankrupt.

We go over these regulatory prescriptions from two viewpoints:
• We comment on how these prescriptions should be taken into account in the design of investment strategies for pension funds.
• When prescriptions are biased, we comment on the resulting departure from optimal asset-liability management strategies.

4.1. Distorted regulatory measures of the liabilities
When regulatory prescriptions are binding yet at odds with the economics of the pension fund, the pension plan will shift its investment strategy to the portfolio that minimises risk as identified by these prescriptions. This “regulatory LHP” is the projection of the regulatory liability on the universe of tradable assets.
4. Prudential and Accounting Constraints on Pension Fund ALM

By defining the regulatory LHP rather than solving the dynamic optimisation problem for each regulatory constraint, we allow a very generic and understandable description of the impact of regulations on the ALM of pension funds. In particular, the definition of the utility function of the participants in the pension fund is not necessary.

Regulations often prescribe the discount rates. We first evaluate the impact of non-economic discount rates on the definition of the regulatory LHP.

In section 4.1.1, we focus on the regulatory and accounting discount rates.
- In VI.1.1.1, we remind the reader that the choice between the government yield curve and the swap yield curve may be linked primarily to practical considerations such as the liquidity of the underlying market.
- In 4.1.1.2, we review the historical standard that involved discounting liabilities at a fixed discount rate, and in 4.1.1.3, we comment briefly on the use of smoothed market yields.
- In 4.1.1.4, we study the accounting LHP, i.e., the portfolio that makes it possible to match the specific discount rate of IAS 19. We study the impact of discounting liabilities with a corporate bond spread and of taking the discount rate from assets of a duration different from that of the liabilities.
- In 4.1.1.5, we study the traditional practice of discounting liabilities at a rate that assumes an equity risk premium. We show that traditional measures of the equity risk premium are pro-cyclical.
- In 4.1.1.6, we remind the reader that the regulatory and accounting discount rates do not reflect the expected value of the pensions for the employees, because the risk of default of the sponsor is not taken into account.

Other sources of bias arise because of other prescriptions for the valuation of liabilities. Section 4.1.2 deals with other biases in the description of the risk factors underlying long-term pension fund liabilities.
- In section 4.1.2.1, we show that in Switzerland mandatory indexation is not measured in the regulatory value of liabilities, even though the regulator requires that liabilities accrue at the official Swiss inflation rate.
- In section 4.1.2.2, we focus more closely on the Netherlands—a nominal framework for real liabilities—where the regulatory measure of the interest rate sensitivity of the liability is distorted.

4.1.1. Non-economic discount rates for the valuation of liabilities: a source of distortion

There are various situations in which the "regulatory LHP" contrasts with the more intuitive "economic LHP", which ensures better replication of actual liabilities over the long run. One source of divergence is that the regulatory and accounting discount rates differ from the risk-free rate used in financial economics, and as a consequence so do the assets that have the same exposure to the discount factors as the liabilities.

The discount rate has a particularly great impact on liabilities whose maturity is beyond the horizon for regulatory measurement. For instance, when an assessment of solvency must be done every year, any fixed liability that matures within a year is best replicated, as standard financial economics advocates,
4. Prudential and Accounting Constraints on Pension Fund ALM

with a zero-coupon bond of the same maturity, or fall in the cash-account category. After all, it will be paid out before it is valued again for regulatory purposes. On the other hand, liabilities that mature beyond one year will be discounted at the regulatory discount rate (as opposed to the risk-free rate in the case of a fixed cash-flow) at the next reporting date. So, any change in that rate has an impact on the value of the liability. Therefore, when defining a “regulatory” LHP, the primary focus should be on the regulatory discount rate rather than on the risk-free rate: prudential funding constraints may force the pension fund to adopt a prudent or even risk-free investment strategy, risk-free, that is, from the prudential regulator’s point of view.

In this case, asset allocation will not merely need to take into account the presence of this constraint; instead, it will be governed entirely by the regulatory LHP, accounting or prudential depending on which constraint is binding.

4.1.1.1. Government bonds or swaps: a question of liquidity

Where liabilities are measured at fair value, regulators have been going back and forth between choosing the government yield curve or the swap yield curve as the measure of the risk-free rate. Lately, the swap yield curve has become a more popular choice:

- In the insurance sector, Solvency II, the upcoming regulation for insurance companies, is a good example of this hesitation: whereas in the latest quantitative impact survey (QIS4), CEIOPS proposed using the zero-coupon yield curve derived from the euro swap yield curve, it had previously recommended using government yields as the risk-free interest rates, as shown on the ECB’s website. In June and December 2008 the CFO Forum, which had previously made no recommendation on the risk-free rate for the calculation of embedded value, recommended the use of the swap yield curve (CFO Forum 2008a and 2008b).
- At pension funds, the two discount rates may coexist. In the Netherlands, where

<table>
<thead>
<tr>
<th>Country</th>
<th>Discount rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>Almost fixed (2.25%)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Swap yield curve (fixed 4% before the FTK)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Market yield + equity and corporate bond risk premium – safety margin (mainly for the increase in longevity)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Minimum (SF179): ten-year government bond yield</td>
</tr>
<tr>
<td></td>
<td>Target from scheme-specific funding requirements (SSF): for pensioners: bond yields; for active members: prudent estimate of fund’s asset returns, with allowance for equity risk premia</td>
</tr>
<tr>
<td>Accounting standards IAS 19/FRS 17</td>
<td>Corporate bond yield (typically AA)</td>
</tr>
</tbody>
</table>
liabilities are discounted at the risk-free rate, the Dutch National Bank releases a stripped swap yield curve. By contrast, in the UK, ten-year government bond yields are used to value the guaranteed minimum liability.

It seems that for very long-term liabilities the choice of the swap yield curve is essentially pragmatic. As a matter of fact, because of the lack of government bonds with a term to maturity of more than twenty years, the swap market may be more liquid. The swap market has also been widely used by the pension fund industry to hedge very long-term liabilities; as it provides the preferred hedging instruments, its yield curve is the natural candidate for the risk-free rate.

The ECB benchmark bond yield, for instance, is the average of government bond yields in the euro zone. As good as this benchmark may be, it is by nature more difficult to replicate, because the pension fund that wishes to receive the ECB yield will need not to enter a single swap deal but to buy a basket of government bonds that matches the basket used by the ECB. In addition, the basket is unknown, and the benchmark rate is not observable in real time.

When it comes to hedging specific (single) cash flows, coupon bonds may, in all countries, be less practical than swaps (see section 3.3.1).

It has often been said that the (long-term) swap spread was illustrative of the credit risk of high quality institutions. However, as cash flows alone are exchanged, not the capital, swaps are the instruments that involve the lowest credit risk for any given rating. Thus, intuitively, the swap spread at long horizons should not deviate very significantly from the swap spread at shorter horizons, as observed in the illustration below from 2002 to summer 2007, the start of the sub-prime credit crisis. In normal times, it is the credit risk component of the interbank rate that should drive the (long-term) swap spread.

The swap-spread curve may thus be subject to other distortions. As swaps are the preferred hedging instruments for long-term liabilities and for swaptions (options on swaps), they may be distorted when there is a large change in demand for government bonds alone (as may have happened in 2000 following the US Treasury buyback announcement) or in demand for swaps alone—after the Lehman bankruptcy, long-term investors had to rebuild the long-term swaps and swaptions that they had engaged in with Lehman as a counterparty (demand for the fixed rate leads to a fall in the rate).
In addition to the liquidity premium in the swap market, macroeconomic risk may also be priced in. The recent extension of the credit default swap (CDS) market to sovereign debt makes it possible to measure explicitly how the macroeconomic risk (the cost of insuring government debt against the risk of default) has contributed to the changing swap curve.

4. Prudential and Accounting Constraints on Pension Fund ALM
While there really was an anomaly or a liquidity premium embedded in the swap curve after the Lehman bankruptcy, the market currently prices a large amount of macroeconomic risk, in the sense that the CDS market prices a non-negligible probability of government default; for the US, the UK and the euro zone this response is largely unprecedented.

4.1.1.2. Discounting at a fixed interest rate is an incentive to a great interest rate asset-liability duration mismatch

Historically, most countries have used fixed rates to discount liabilities. The Netherlands used a fixed 4% discount rate, Germany a 6% rate for book-reserved pensions, and now the nearly fixed 2.25% for Pensionsfonds (and Pensionskassen).66

In this case, the value of liabilities is totally independent of market interest rates. When the bond portfolio is marked to market, the portfolio that immunises the funding ratio against movements in financial markets (mainly interest rate movements) is . . . the cash-account or, when regulatory reporting takes place every year, the one-year zero-coupon bond.

After all, when regulatory reporting takes place every year, it is the regulatory LHP that will reach the fixed value of the discounted benefit obligation DB in one year (with a maturity $T-1$) at the regulatory discount rate $rc$, value equal to $v=DB/(1+rc)^{T-1}$. This is replicated with a zero-coupon bond of one year, today worth $v/(1+r_1)$, where $r_1$ is the current one-year interest rate.

Because discounting liabilities at a fixed interest rate leads to a situation in which the LHP is the cash account, the optimal portfolio is no longer made of three blocks (the cash account, the LHP, and the optimal investment portfolio) but of two (the cash account and the optimal investment portfolio).

So, asset management techniques alone (without the proper use of ALM techniques) can be used to comply with the regulations. In practice, these requirements mean the...
allocation of assets is subject to a form of Value-at-Risk constraint, in which the probability of breaching the minimum funding requirement over the reporting horizon (usually one to three years) is less than the level of confidence judged sufficient by management—in more practical terms, for small structures, all that is required is that the market value of the assets (optimal investment portfolio + investment in the regulatory LHP of one-year bonds) remain superior to the (fixed) liability value after a shock that is representative of the confidence interval chosen (97.5% or more).

4. Prudential and Accounting Constraints on Pension Fund ALM

4.1.1.3. Discounting with a smoothed market yield reduces the duration of the replicating portfolio

There are multiple variations on the regulatory discount rate. A historical standard is to smooth the market yields used for discounting. Smoothing the discount rate has the obvious effect of making the valuation of liabilities less sensitive to market yields; in other words, it reduces their modified duration.

For instance, when the discount rate is a two-year average market yield, the sensitivity over a one-year period is but half what it would be without smoothing.

And so the regulatory replicating portfolio has a position in bonds exactly half the size of that of the economic replicating portfolio. The cash account makes up the other half.

In the countries where asset prices were also reported at a smoothed market price, the two sides of the balance sheet were equally smoothed, and in essence the situation was akin to that of having market prices on both sides of the balance sheet, except that the sensitivity of open risk positions—the non-replicating part of the strategy—was halved, leading to a greater ability to take on risk.

4.1.1.4. Discounting fixed cash flows with credit yields (IAS 19) requires forward credit rate agreements as a match

Sponsors are also sensitive to accounting constraints, because they have an impact on both their balance sheets and their PtL. Pension plans may thus be optimised from a treasurer’s point of view—the volatility of the impact of pension funds on the PtL may be minimised, for instance. This usually involves monitoring short-term deviations from the IAS 19 funding ratio and strict avoidance of any under- or over-funding greater than 10%. In FRS 17, the UK equivalent of IAS 19, the market impact is fully recognised in the balance sheet of the sponsor without any smoothing.

For the sponsor, then, the discounting interest rate used in its own books because of IAS 19 may be of greater concern than the rate used by the pension fund for regulatory reporting. As the current version of IAS 19 recommends “spreading”, i.e. the use of corporate bond yields to discount liabilities, sponsors that do not benefit from the IAS 19 exception will tend to build the LHP with credit instruments rather than government bonds. Investing in securities that are risk-free from an accounting perspective creates what we call an “accounting LHP”.

It is clear that only exposure to credit securities on the asset side can match exposure to credit yields on the liability side. However, when the reporting period is taken into account, the replicating
portfolio is made of forward credit yield exposure rather than current credit risk exposure. This use of forward credit yield can be illustrated as follows: suppose a one-year interval between two valuation dates; it is the one-year forward sensitivity to the AA corporate bond yield that should be matched, usually with forward rate agreements (FRAs).

**Hedging the immediate interest rate exposure**

**Instantaneous interest rate sensitivity of the accounting liability**

Let us suppose that the yield on security A is used for discounting purposes. A has a defined maturity $T_A$ and a final payoff of 1. The liability considered L also has a final payoff of 1 in $T_l$. Let current time $t=0$, and next reporting time $\Delta T$.

$$A(0) = e^{-r(0, T_A) T_A}$$

and

$$\frac{\partial A(0)}{\partial r} = -T_A \cdot e^{-r(0, T_A) T_A}$$

$$L(0) = e^{-r(0, T_l) T_l}$$

and

$$\frac{\partial L(0)}{\partial r} = -T_l \cdot e^{-r(0, T_l) T_l}$$

The exposure $w_A(0)$ that minimises the net sensitivity to (instantaneous) interest rate changes is:

$$w_A(0) = \left. \frac{\partial L(0)}{\partial A(0)} \right|_{r(0, T_l)} = -\frac{T_l}{T_A} \cdot e^{-r(0, T_A) T_A} \cdot e^{-r(0, T_l) T_l}$$

**FRA hedge of the accounting sensitivity at the next reporting date**

However, rather than instantaneous changes in the yield of credit security A, the sponsor is interested in hedging the exposure to the yield at the future reporting date $\Delta T$, which is $r(\Delta T, T_A+\Delta T)$ when the discount rate is a constant maturity rate.

Suppose an FRA can be traded on the market. The FRA pays $(f(0, \Delta T, T_A)-r(\Delta T, T_A))$ where $f(0, \Delta T, T_A)$ is the forward rate considered at time $t=0$ for time $\Delta T$ to $T_A=T_A+\Delta T$. In that case the sensitivity of this FRA to the forward rate is 1.

As a consequence, rather than investing in $A(0)$, the sponsor may prefer that the pension fund enter an FRA, with the following weight/amount:

$$w_{FRA}(0) = \left. \frac{\partial L(0)}{\partial r} \right|_{r(\Delta T, T_A+\Delta T)} = -\left( \frac{TL}{TA} \cdot e^{-r(\Delta T, T_A+\Delta T) \cdot (TL-\Delta T)} \right)$$

**Poor convexity performance of the FRA hedge**

In the preceding calculations, the interest rate sensitivity was matched, but not the convexity. After all, the payoff from the FRAs is proportional to the level of interest rates, whereas discounting makes the accounting value of the pension liability a convex rather than linear function of interest rates.

As a matter of fact, the LHP and the liability together form a book with the following value in $\Delta T$:

$$B(\Delta T) = -(T_l - \Delta T) \cdot e^{-f(0, \Delta T, T_l+\Delta T) \cdot (TL-\Delta T)} \cdot \left( r(\Delta T, T_A) - f(0, \Delta T, T_A) \right) - e^{-r(\Delta T, T_A) \cdot (TL-\Delta T)}$$

Its sensitivity reads

$$\frac{\partial B(\Delta T)}{\partial r(\Delta T, T_A)} = -(T_l - \Delta T) \cdot e^{-r(\Delta T, T_A) \cdot (TL-\Delta T)}$$

$$+ (T_l - \Delta T) \cdot e^{-r(\Delta T, T_A) \cdot (TL-\Delta T)}$$

$$= -(T_l - \Delta T) \cdot e^{-r(\Delta T, T_A) \cdot (TL-\Delta T)} - e^{-r(\Delta T, T_A) \cdot (TL-\Delta T)}$$

The expectation of the sensitivity at $t=0$ is nil; its convexity is the convexity of the liability (as the FRA that pays $r(\Delta T, T_A)$ at
4. Prudential and Accounting Constraints on Pension Fund ALM

Supposing that the FRA pays out \( r(j,j+1) - f(0,j,j+1) \) at time \( t=j \) when the market rate \( r(j,j+1) \) is observed, this formula is broken down into

\[
dsc_j = e^{-\sum_{i=0}^{j} r(0,i,j+1) \frac{\Delta T}{T_A}} \cdot e^{-\sum_{i=0}^{j} r(0,i,j+1) \frac{\Delta T}{T_j}}
\]

which shows the impact of discounting, and \( w_j \) the required amount of FRAs, with

\[
w_j = -\frac{T_j - 1}{T_A} \cdot e^{-\sum_{i=0}^{j} r(0,i,j+1) \frac{\Delta T}{T_j}} \cdot e^{-\sum_{i=0}^{j} r(0,i,j+1) \frac{\Delta T}{T_A}}
\]

The decomposition naturally arises because each FRA receives \( r(j,j+1) \) in \( t=j \) and has a unitary sensitivity to the \( j \)th interest rates before discounting, and the sensitivity of \( dsc \) after discounting.

It is interesting to note that in this version the LHP has a convexity much closer to that of \( L \)—after all, payments from the FRAs are postponed. The better convexity match is illustrated below.

The assumptions are that:
- \( r(0)=5\% \)
- \( T_j=15 \)
- \( T_A=9 \)
- The hedge is calculated at time \( t=0 \) and held until \( t=1 \).

The variable of interest is \( L(1) \). Its expectation at time \( t=0 \) is \( E_0(L(1)) \) and it reads:

\[
E_0(L(1)) = e^{-\frac{\sum_{i=0}^{T_A} f(0,i,1)}{T_A} \frac{\Delta T}{T_A}}
\]

The assumptions are that:
- \( r(0)=5\% \)
- \( T_j=15 \)
- \( T_A=9 \)
- The hedge is calculated at time \( t=0 \) and held until \( t=1 \).
4. Prudential and Accounting Constraints on Pension Fund ALM

Hedging with corporate bonds.
The hedges proposed below can also be replicated internally with a long exposure to a bond with maturity $T_A'$ and a short exposure to a one-year bond. Hedging with the equivalent credit bond has the following advantages over FRAs:

- When one buys only the long bond, the investment is cash as opposed to derivatives, which makes it possible to ignore additional reporting requirements in some jurisdictions.
- As the payoff from the cash instrument is made on the same date as that of the liability, discounting leads to approximately equal convexity for both the LHP and the liability.

This construction, however, has the following disadvantages with respect to FRAs:

- In practice, the construction may be very difficult, because perfectly matching flows with bonds is impossible, as illustrated in section 3.2.a. After all, building a replicating portfolio of bonds generally requires short exposures. Even in the simplified case of a bullet liability and available zero-coupon corporate bonds as a match, attempts to match forward rather than current credit yield exposure lead to short exposure up to the following reporting date. Short exposures may be even more difficult to justify in the asset allocation of pension funds than investment in derivatives such as FRAs.

Figure 4.3: Liability-hedging portfolio under IAS 19
Under IAS 19, immunisation against the change of the discount rate requires credit risk exposure. A portfolio of forward credit rate agreements (FRA) best captures credit risk on the liability side.

On the upper part of the graph, the red line shows the discounted liability value, as a function of market interest rates (supposing a flat yield curve at $t=1$). The black dotted line shows the payoff of the single FRA entered into in the first portfolio. As the payoff is received at $t=1$ and not discounted, the black curve is perfectly linear. By contrast, the blue line is convex. It is, however, slightly less convex than the liability, as on average the payoffs are received earlier than the liability is paid. The two lines are up-scaled so that their expected payoff is not zero but rather the expected liability value, and is easily visualised.

On the lower part of the graph, we see the book composed of the LHP on the asset side and of the liability value on the liability side (scale reads on the right-hand scale). The book in which the LHP is made of multiple FRAs is much more stable than that in which a single FRA is used for the LHP.
• When it comes to exposure to future interest rates, FRAs are practical because they make it possible to avoid having to deal with the default risk borne between \( t=0 \) and \( t=\Delta T \) when investing in a corporate bond at time \( t \) to match the exposure of the liability to credit interest rates at time \( T \). Let us consider that credit risk is decomposed as spread risk, default risk and migration risk (as time passes, some bonds will be downgraded to A, whereas others will be upgraded to AAA). On top of spread risk, the management of which has been defined, one also needs to manage default and migration risk when investing in corporate bonds:

• Default risk: even though the probability of default of AA bonds over one year is low, credit risk means that investing in matching corporate bonds also requires a degree of sophistication. The portfolio must be as granular as possible so as to avoid idiosyncratic risk, i.e., additional default risk because of the lack of diversification of the corporate bond portfolio.

• Transition risk: retaining a constant credit yield exposure to AA and avoiding exposures to A and AAA spreads as a result of migrations also implies rebalancing the bond portfolio.

Real-life situations may be more complex still, requiring the use of structured products, futures, or derivatives. For instance, we have seen the example of a discount rate calculated as the five-year iboxx yield, minus a fixed margin, such as twenty basis points.

Practically, replicating the exposure means investing in the product used to compute the discount rate and, when available, in a portfolio of FRAs used to calculate the accounting value of the liability.

4.1.1.5. The traditional practice of discounting with an equity risk premium (ERP) is pro-cyclical

**Discounting with an ERP is incompatible with a run-off approach**

In the financial community it has often been argued that discounting liabilities at an equity risk premium means under-estimating these liabilities. This is dangerous in a run-off or liquidation approach, because no third party would accept a book in which the value of assets backing liabilities falls short of the actual value of the liabilities. As The Economist notes, discounting liabilities at equity return rates is equivalent to stating that one euro of equities is worth more than one euro of bonds, or to borrowing money from the bank solely against the expected performance of leveraged investments. Were the bank to buy the idea, it would quite possibly prefer to invest the money itself and keep the long-term extra returns, that is, transform a billion euros of bonds into equities when it is proven that the latter are worth more.

From a regulatory perspective, discounting at an equity return is meant to allow pension funds to take risk. As this valuation method is incompatible with a liquidation or run-off perspective, it naturally must be considered only as part of a long-term perspective, and risk-taking in the pension fund allowed to the extent that the strength of the plan and of the sponsor are deemed sufficient to take these risks on.
In other words, it is essential that the pension fund use a continuity test to demonstrate its capacity to withstand equity risk, as is done in the Netherlands, and, more broadly, that it use an ALM model that spans several years and takes future contributions into account.

This traditional practice is pro-cyclical and may trap pension funds. The traditional practice of discounting at an ERP is pro-cyclical, i.e., it amplifies the impact of the business cycle on the financial health of the pension fund. Many financial institutions have been using an historical estimate of the risk premium, computed over a period of, say, fifteen years, sometimes depending on the maturity of the liabilities. This practice, without any further analysis, may lead to the “equity risk premium trap”, i.e., the risk of being trapped in permanent underfunding after market downturns.

After all, when the value of assets falls, so do historical estimates of the risk premium. Falls in expected returns trigger a further rise in the reported value of the liability, and therefore further lower the funding ratio, involving a second round of adverse consequence on the reported health of the pension fund.

An illustration of the ERP trap is found in table 4.1:

Table 4.1: Historical ERP trap
In regulations that allow discounting at an equity return, the discount rate is generally the sum of long-term risk-free rates, and of an allowance for equity returns, determined as the product of the historical risk premium times the equity weight in the portfolio. The use of the historical risk premium over a limited time period (e.g., fifteen years) is an incentive to invest more in equities at the peak of the valuation cycle, after returns have been strong, especially when the pension fund is underfunded. After a crash, which deepens underfunding and lowers the ERP estimate, a pension fund may be forced to cut its equity exposure and may remain permanently underfunded.
4. Prudential and Accounting Constraints on Pension Fund ALM

Suppose that the defined benefit is a ten-year lump sum of terminal value 148. The risk-free rate is 4%, and the historical risk premium is 3%. Overall, the equity discount factor at t=0 is exp(-10*7%)=0.51, while the risk-free discount factor is exp(-4%*10)=0.68.

Regulation requires full funding at all times.

For an asset value of 85 compared with a liability value of 100 when discounted at the risk-free rate, it is necessary to invest in risky securities so as to raise the discount factor that will be applied to the liabilities. When the equity weight rises, the reported liability value falls. To be fully funded (liability value = asset value), our pension fund needs to invest 60% of its assets in equities and 40% in the risk-free zero-coupon bond.

After one year, equities have fallen by 5%, and instead of outperforming bonds by the expected 3% they have underperformed them by 9%. As the ERP is measured over fifteen years, this 12% translates into a 0.8% reduction in the ERP. In turn, this reduction increases the value of liabilities in such a way that, however the assets of the pension fund are allocated, it must report a deficit or underfunding.

As a result of underfunding in the previous year, the pension fund had an incentive to invest heavily in equities, but in the following year it deviates from equilibrium. Here, the temptation for management of the pension fund—and perhaps also for some supervisors—may be to go risk-free, in other words, to move from heavy investing in equities to full investing in bonds.

It now has a (permanent) lack of funding of €16, or 15%.

A more formal way to explain pro-cyclicality is to derive the equity delta of the same pension fund. We will show that retrospective measures of the ERP add to equity sensitivity.

Let w be the proportion of equities in the portfolio.

\[ L(t) = L_0 \cdot \{w \cdot e^{-\{t+\text{ERP}(t)\}T} + (1-w) e^{-\{T-t\}}\} \]

with

\[ \text{ERP} = \frac{1}{T} \cdot \ln \left( \frac{S(t)}{S(T)} \right) - r \]

\[ A(t) = A_0 \cdot w \cdot \frac{S(t)}{S_0} + (1-w) \cdot B(t,T), \]

with

\[ B(t,T) = e^{-\{T-t\}} \]

And \( T \) is the time over which the ERP is measured.

\[ \frac{\partial A}{\partial S} = w \cdot \frac{A_0}{S_0} \]

\[ \frac{\partial L}{\partial S} = -w \cdot e^{-\{t+\text{ERP}(t)\}T} \cdot \frac{T}{S(t)} \]

So, as the liability measure \( L(t) \) has a negative sensitivity to stock prices because of the retrospective measure of the ERP, the net sensitivity of the pension fund to equity prices is greater than the asset sensitivity alone.

Overall, in terms of stability, the incentives to hold a large share of equities when a pension fund is underfunded are offset by the great sensitivity to equity prices brought about by the measure of the ERP.
Regulators and supervisors should work out recommendations to avoid pro-cyclicality, e.g., recommend the use of a forward-looking ERP. That regulators are willing to allow a certain level of risk-taking in a pension fund, or even that they consider equities necessary to replicate long-term real commitments is understandable. Suppose the use of an ERP to discount liabilities is deemed the most practical way by regulators.

We then recommend using a forward-looking measure of the ERP, a measure that makes it possible to avoid some of the pitfalls of discounting at an ERP.

First, unlike retrospective ERP, forward-looking measures are not contrarian indicators of stock prices and do not send mistaken investment signals.

In the chart below, we use data from Shiller to compute the historical ERP for the US market. The historical ERP is measured over fifteen years as the most common naïve method:

$$ERP(t)=\left(\frac{SP(t)}{SP(t-15)}\right)^{1/15}\cdot LTG(t-15)$$

Where SP is the price of the S&P500 index and LTG is the nominal long-term bond yield as presented in Shiller’s data.

The red line shows the future annual outperformance of bonds over a fifteen-year horizon using the same methodology:

$$Future\ Outperformance(t)=\left(\frac{SP(t+15)}{SP(t)}\right)^{1/15}\cdot LTG(t)$$

The graph shows clearly that the historical measure of the ERP is actually a contrarian indicator of future equity outperformance. Historically, after all, the ERP rises during stock market bubbles; it predicts that equities will continue to perform well, when what usually happens is that they fall. Symmetrically, it states that equities are poor investments precisely at the bottom.

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Figure 4.4: Historical equity risk premium and future outperformance
A high historical ERP (over fifteen years here) predicts if anything underperformance and is a dangerous input in ALM models.
of economic cycles, whereas over longer horizons they are the best investments. So, in general, historical ERP is a misleading indicator of the outperformance of stocks, but it is also a contrarian indicator at the peaks and valleys of the business cycle.

Forward-looking measures of the ERP are far more suitable as they send more adequate investment signals. In the graph below, we compute the ERP as in the so-called Fed Model, based on Shiller’s data both for the long-term bond yield and for the price-earnings ratio.\textsuperscript{68}

\begin{equation}
\text{Fw}_{\text{ERP}} = \frac{1}{\text{trailing PE}} - \text{LTG} / 100
\end{equation}

As the figure shows, Fw\_ERP and future equity outperformance are positively correlated, and despite the poor predictive power of Fw\_ERP in the early 1920’s, it has since remained a good forecasting tool for the fifteen-year outperformance of equities. Equity prices that are high relative to earnings and risk-free earnings call for prudence, whereas after a market crash the prospects of higher equity gains may cause the pension fund to slash equity exposure and thus to fall into the trap of underfunding and low returns.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure4.5.png}
\caption{A valuation-implied equity risk premium has forecasting power. Valuation-implied ERP has had significant forecasting power on the fifteen-year outperformance of the stock market since the 1930’s. Very similar results are obtained with total return performance.}
\end{figure}

The forecasting power of a forward-looking ERP makes it possible to avoid some pro-cyclicality.

Once again, the example provided here is for illustration purposes only; pro-cyclicality can be avoided in a number of ways. Spreading, for instance—discounting with AA corporate bond yields—may provide some protection. A cyclical downturn, after all, will make asset prices fall, but it will also widen corporate spreads, and as a

\textsuperscript{68} Shiller’s PE ratio is the ratio of the S&P500 price index to the ten-year “trailing” earnings, i.e. the average of earnings per share over the ten preceding years.
consequence lower the value of the discounted liability.

In any case, regulations that allow discounting at an ERP, as well as pension funds that discount with a risk premium, should ensure that the ERP used for this purpose is a forward-looking rather than a backward-looking measure.

4.1.1.6. Regulatory discount rates do not reflect the fair value of the pension benefit for the employees

As the aim of prudential regulations is to protect pension fund participants, it should provide incentives for the adequate understanding, measurement and management of all sources of risk.

From a theoretical standpoint, pension liabilities are a particular claim on the assets of the sponsor. They are a collateralised form of debt held by the workers and pensioners of the sponsor, a form in which the assets of the pension plans are the collateral, in exchange for which the company receives the present value of lower wage demands.

This analysis suggests that the rational valuation of pension liabilities regarded as (defaultable) claims issued by the sponsor company to workers and pensioners should be cast within the context of a standard corporate finance model for defaultable bond pricing.

In other words, the regulatory framework fails to take full account of company-specific credit risk in liability streams and of how it is affected by capital structure decisions made by the sponsor and asset allocation decisions made by the pension fund. In practical terms, this failure does not mean that pension liabilities are over- or undervalued, but that the risk of default of the sponsor is not reflected in the valuation, and as a consequence will not be reflected in the ALM strategy of the pension fund.

For management purposes, taking into account the risk of bankruptcy of the sponsoring company is important. Suppose that pension management attempts to maximise the market value of the pension benefit to be received by plan members. Participants make no future contributions in the event of deficits, and have no additional benefits in the event of surpluses.

- When the risk of default is ignored—in other words, assuming unlimited capacity to erase plan deficits—plan participants are indifferent to the asset allocation and funding policy of the pension plan. After all, the benefit received does not depend on the terminal asset value or on the terminal funding ratio.
- When the probability of sponsor default is taken into account, the participant will seek to minimise the impact of the joint probability of underfunding and default. When liabilities are fully hedgeable and the pension fund is sufficiently funded, employee welfare is maximised when the pension fund replicates the liability and does not take any further risk. When the liability is not fully hedgeable (i.e., wage-indexed liabilities or longevity risk), the pension fund will seek protection against the risk of default of the sponsor, perhaps with credit default swaps (CDS).

We argue that there should be incentives to manage the participants’ fair value pension rights, but this pension debt should by no means be reported in...
companies’ accounts or serve as a basis for prudential funding requirements. After all, discounting pension liabilities taking into account the sponsor’s credit risk would mean that in any situation the pension fund is sufficiently funded and as a result pension funds and sponsors would avoid any funding requirement. The objective of measuring the impact of sponsor’s risk of default is simply to hedge this risk, by changing either the asset allocation or the contribution rates, depending on the contract between the sponsor and participants.

We will note that this valuation exercise is very similar to that of the fair pricing for pension insurance. In the US, for example, the Pension Benefit Guaranty Company (PBGC) charges sponsors a premium determined solely by the extent of the funding shortfall; the sponsor’s overall financial health is ignored. Pension plans pay the PBGC yearly insurance premiums: $19 per worker or retiree plus $9 for each $1,000 of unfunded vested benefits in single employer plans.

The British Pension Regulator, by contrast, explicitly determines the levy paid to the PPF as a function of both underfunding and the likelihood of sponsor default.

4.1.2. Other biases in the regulatory measure of the liabilities

In the current section, we highlight the use of diverging hypotheses for the pricing of liabilities—yet another source of the divergence of regulatory and economic LHPs.

Regulations tend to prescribe measurements of the regulatory liability. In section 4.3.1, we study the case in which unconditional, mandatory indexation is not measured in the regulatory value of liabilities.

In section 4.3.3, we focus more closely on the Netherlands, where liabilities are reported net of any conditional indexation, even though indexation policy is arguably essential to the asset and liability strategy and to a definition of the appropriate portfolio. Borrowing from option-pricing, we show that the regulatory nominal liability and the internal target liability make for bounds within which the interest rate sensitivity of the assets should lie. While modern ALM involves dynamic allocation to two funds—the LHP and the performance-seeking portfolio—taking regulatory constraints into account may involve defining the LHP itself as a dynamic exposure within the bounds defined by the regulator and internally. Although the exposure within these bounds is not mathematically defined here, it can be illustrated as follows:

- Well-funded pension funds will focus on their long-term targets, and the interest rate sensitivity of their liabilities will be close to that of the long-term target.
- When a pension fund has a low funding ratio it will reduce its equity exposure and bring the duration of its bond portfolio into line with the regulatory measure of liability duration; this shift offers greater short-term protection and reduces funding requirements. We call the assets that replicate the prudential measure of the liability the “prudential LHP.”

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69 - This is similar to measuring and reporting the guaranteed liability in insurance companies but not the expected profit-sharing.
70 - By indexation policy we mean both target indexation and the way it is achieved in practice (asset allocation, how indexing is decided conditional to the funding ratio, etc.).
4.1.2.1. Failing to value mandatory indexation may also lead to poorer replication

One of the challenges of the development of occupational pensions is to protect the purchasing power of retirees.

In Switzerland, the benefits paid out to participants are strictly regulated, and accumulated savings are inflation-protected. These must be increased by the rate of inflation, as published by the office for statistics, every two years. However, future inflation-related increases are not taken into account in the valuation of liabilities. So, minimum liability is viewed as nominal (i.e., a series of fixed cash flows), even though it is in fact real (i.e., a series of inflation-linked cash flows).

Naïve replication of this view would lead a pension fund that is seeking a risk-free ALM strategy to invest in nominal bonds and to subject itself to inflation risk that will grow over the medium and longer term.

In theory, inflation-linked bonds from the home country would be adequate to replicate inflation exposure. In practice, however, the supply of these bonds is concentrated in the US, Japan, the UK, and France, and some of the countries with the largest pension fund industry, such as the Netherlands and Switzerland, have little access to the securities that would allow perfect matching of their inflation exposure.

For such countries, replicating domestic inflation is a challenge; pension funds must resort to nicely correlated assets as opposed to perfectly replicating ones.

In their search for alternative assets such as private equity, real estate, commodities, infrastructure projects, and more recently hedge funds, some large pension funds have explicitly focused on the inflation-hedging properties of these assets, on both stand-alone (each asset class separately) and integrated bases (these asset classes combined). Hoevenaars et al. (2005) illustrate this approach. Their work is summarised in section 3.3.b.

In Switzerland, the problem of inflation replication is exacerbated by quantitative restrictions and a small home market.

4.1.2.2. A nominal regulatory framework for real pension liabilities, as in the Netherlands, increases the reported duration of liabilities

As explained in section 2.2.4.1, the fall in the funding ratio of pension funds in the early years of the new millennium triggered two simultaneous and yet contradictory reactions:

• The regulator implemented a new regulatory framework for pension funds, the FTK, a risk-based framework that requires buffers for any risk-taking on top of the replication of the prudential liability—the latter is measured on an accrued basis, i.e., excluding any unconditional indexation.
• At the same time, pension schemes ended the systematic indexing of pension benefits to wages, and stated that any indexing was conditional to the funding ratios of the pension fund.

As indexing is now conditional on the wealth of the fund, liabilities are highly dependent on asset allocation and long-term targets. However, liabilities are reported to the regulator as nominal liabilities, that is, fixed liabilities, replicable
from a regulatory standpoint with fixed-income assets only. We will illustrate how these views conflict.

The duration paradox in the light of the option-pricing framework

The modified duration of conditionally indexed pension liabilities is radically different from that of fixed cash flows.

In the current sub-section, we borrow from the “option-pricing approach” to insurance liabilities, as illustrated in Briys and Varenne (2001).

$L$ is defined as a lump sum with a fixed term (e.g., twenty years), without underwriting risks, but with conditional indexation.

To take into account the risk-sharing mechanism specific to pension funds, employer and employee contributions are increased when the pension fund is underfunded; losses are thus borne by both employer and employee.

Because of regulatory funding requirements, the value of the assets, $A$, is initially higher than that of the liability. This translates into a free asset ratio, $a = L_0/A_0$. In the Netherlands, for a fund at equilibrium, $a = 0.7$ approximately.

In most cases, the guaranteed rate $r^* = 0$: any revaluation of savings is conditional.

The illustration shows that when the asset value is below $L^*(T)$ contributions are increased for both employee and sponsor.

We assume that liability $L$ increases with a fixed participation rate $\delta$ as soon as the funding ratio crosses a defined threshold. In reality, in most pension funds, $\delta$ tends to increase as the surplus increases, adding again to the convexity of the liability as illustrated in the current section.

Between the promised benefits and 130% of that value, asset performance increases funding alone, not employee benefits.
4. Prudential and Accounting Constraints on Pension Fund ALM

Above that level, pensions start rising, by almost the full rise in asset value (by 95% in the graph). The buffer \(B_T = A_T - L_T\) gets slightly larger.

The buffer \(B_T\) is clearly valued as a call option on the value of the asset beyond the guaranteed minimum liability, minus the call option that is paid out to the employees when the funding ratio is higher than 130%.

\[
B_T = \max(0, A_T - L_T) - \alpha \delta \max(0, A_T - \frac{L_T}{\alpha})
\]

The liability is seen as the guaranteed part, plus participation in asset performance when the funding ratio is above 130%, minus the probability of facing contribution increases equal to \(\gamma\) times the losses in the event of underfunding,

\[
L_t = L_t P(t, T) - \gamma \cdot P_t (A_t, L_t) + \delta \alpha C_t (A_t, \frac{L_t}{\alpha})
\]

As in Briys et al. (2001), we use a single-factor Vasicek model for the term structure of interest rates. In Vasicek (1977), the only source of fluctuation in interest rates is that of short-term interest rates, that describes overall sensitivity to interest rates.

\[
\eta_A = -\frac{1}{A_t} \cdot \rho \cdot \sigma_A = -\rho \frac{\sigma_A}{\sigma}
\]

In the Vasicek setting

The sensitivity of the assets reads:

\[
\eta_A = -\frac{1}{A_t} \cdot \frac{\partial P(t, T)}{\partial r_t} = H(T - t) = \frac{1 - e^{-\alpha (t - T)}}{\alpha}
\]

The interest rate sensitivity is pulled back to that of the assets by the participating call (with strength \(\delta \alpha \text{N}(d_3)\)) and the participating put (with strength \(\gamma \cdot \text{N}(-d_1)\)).

\[\text{(1)}\]
The interest rate sensitivity of the investment strategy should fall between the regulatory "nominal" and the internal "target" interest rate sensitivities. From (1), $\eta_L$ lies within the two following bounds:

- $\eta_L$, the interest rate sensitivity of the assets, assumed to result from unconstrained long-term optimisation by the pension fund, or matching the long-term target liability of the pension plan. For this reason, $\eta_L$ may be called the target interest rate sensitivity.

- $\eta_P$, the interest rate sensitivity of a zero-coupon bond that matches the nominal liability used as a reference by the regulator. So, $\eta_L$ may be called the regulatory interest rate sensitivity.

**Regulatory and economic interest rate sensitivities**

For a numerical example, we now take the following parameters:

- **Pension fund:**
  - Free asset ratio = 0.75 (equivalent to a funding ratio of 130%, i.e., equilibrium for a typical Dutch pension fund)
  - $\delta = 95\%$. The participation rate in pension funds is very high, as pension funds are not-for-profit organisations.
  - $\gamma = 50\%$: additional contributions are shared in the event of underfunding.
  - $r^* = 0\%$ is the classic case in which only nominal promises are made, and liability is increased with conditional indexation.

- **Yield curve:**
  - Starting short-term interest rate $r_0 = 4\%$
  - Volatility of the short-term rate $\sigma = 1.5\%$
  - Speed of mean-reversion $a = 15\%$
  - Mean reverting level $b = 5\%$

- **Asset-allocation:**
  - Correlation of asset value and interest rates: $\rho = -20\%$
  - Asset volatility $\sigma_a = 20\%$

The interest rate sensitivity of the liability is much closer\(^{72}\) to that of the asset than to that of the regulatory view.\(^{73}\)

---

\(^{72}\) For long-term liabilities the distance to the asset sensitivity is 15% of the distance between the asset sensitivity and that of the nominal zero-coupon bond.

\(^{73}\) The regulatory interest rate sensitivity is defined here as the interest rate sensitivity of the zero-coupon nominal bond that replicates the nominal guaranteed liability; it does not take conditional indexation into account.

Figure 4.7a: Naturally, when pension funds, under prudential pressure to reduce risk, allocate assets in such a way as to reduce this pressure, the actual liability is shifted toward the regulatory liability. In the illustration below, the pension fund closes half of the reported duration gap, and as a consequence the interest rate sensitivity of the liability also shifts approximately halfway closer to the black line.
Analysis of interest rate sensitivities in the FTK.

We suppose now that the objective of the pension fund is to index the liability to inflation, with a funding ratio and an investment strategy that allow the replication of this payoff. The liability, a lump sum payable in twenty years, is then proxied as the zero-coupon inflation-linked bond that replicates it.

The replicating zero-coupon inflation-linked bond pays the inflation index at maturity \( T \), or \( I(T) \), and its price is \( e^{-r T} E(I(T)) \), where \( r \) is the nominal-zero coupon interest rate.

Because of the correlation of interest rates and expected inflation, the interest rate sensitivity and the duration of our zero-coupon inflation bond is much lower than that of a nominal bond. The nominal rate \( r \) is equal to the real interest rate \( r \), plus the expected inflation rate, \( r = r + \hat{\pi} \), so that \( P = e^{-r T} * e^{\pi T} = e^{-r T} \), and the zero-coupon inflation-linked bond is sensitive only to the change in the real interest rate or to a mere fraction of the source of interest rate risk.

For a numerical illustration, we apply the calibration chosen by the Dutch regulator. The FTK combines inflation risk with interest rate risk in the first sub-module of the quantitative requirements. Here, the following stress-test is applied: inflation rises or falls by 30% and long-term interest rate yields rise or fall by 24% from current levels.

In the upwards stress-test provided by the FTK, future and expected inflation rise from 2% to 2.6%, while long-term bond yields rise from 4% to 5% (4%*1.24=4.96%). In the downwards stress-test, inflation falls from 2% to 1.54%, while interest rates fall from 4% to 3.23% (4%/1.24=3.23%).

The FTK stress-test is:

**Upwards shock:**

The value of the replicating bond changes by:

\[
\Delta_k = \frac{(1 + 2.6\%)^{20}}{(1 + 4.96\%)^{20}} - 1 = -6\%
\]

74 - It generally pays \( I(T)/I(0) \) where 0 is the issuance date, but with the convention that \( I(0)=1 \) the formula is correct.

75 - See section 2.2.3.a for detailed specification of the FTK.
4. Prudential and Accounting Constraints on Pension Fund ALM

By comparison, the relative change in value of the “regulatory” nominal liability is:

\[
\Delta_P = \frac{(1 + 4.96\%)^{20} - (1 + 4\%)^{20} - 1}{1} = -17\%
\]

So in the upwards shock the regulatory liability values fall more than the asset value, which has a positive impact on the funding ratio.

Downwards shock:
The value of the replicating inflation-linked bond changes by:

\[
\Delta_A = \frac{(1 + 1.54\%)^{20} / (1 + 2\%)^{20} - (1 + 3.23\%)^{20} / (1 + 4\%)^{20} - 1}{1} = 6\%
\]

By comparison, the relative change in value of the “regulatory” nominal liability is:

\[
\Delta_P = \frac{(1 + 3.23\%)^{20} - (1 + 4\%)^{20} - 1}{1} = 16\%
\]

So in the downwards shock the regulatory liability value rises significantly more than the value of the replicating asset, which has a negative impact on the funding ratio.

When interest rate risk is considered together with inflation risk, as should be the case in any realistic assessment of risk, the sensitivity of the replicating assets is roughly 40% of the sensitivity of the regulatory liability.

In absolute (€) terms, the downwards shift involves the following calculation for our twenty-year €1 real liability:

\[
\Delta_A = \frac{(1 + 1.54\%)^{20} / (1 + 2\%)^{20} - (1 + 3.23\%)^{20} / (1 + 4\%)^{20} - 1}{1} = -0.041
\]

\[
\Delta_P = \frac{(1 + 3.23\%)^{20} - (1 + 4\%)^{20} - 1}{1} = 0.0736
\]

\[
\Delta_{\text{DW} \text{WN}} = -0.041 - 0.0736 = -0.0325
\]

In other words, for a perfectly matched interest rate and inflation exposure, the FTK implies a requirement of 3.25 cents per euro of twenty-year (real, reported as nominal) liability, or of 3.25% of the liability.

In practice, Dutch pension funds have lengthened duration with a mix of swaps and swaptions.

We have seen that the long-term targets of pension funds and regulation create boundaries within which the interest rate sensitivity of the assets backing pension liabilities can be managed. When the funding ratio falls, pension funds must decrease regulatory risk exposures, and often partially close the regulatory duration gap.

Two very interesting market developments have taken place in this respect.

First, Dutch pension funds effectively lengthened the duration of their assets. When the FTK came into force, funds initially reported an average asset duration of five years, against an average regulatory duration of sixteen years for liabilities, i.e., a duration gap of more than ten years—a 1% change in interest rates, consistent with the calibration of the FTK, is reported as likely to change the funding ratio by 10%. In other words, interest rate risk as reported required a 10% increase in the funding ratio.

Many pension funds have thus partly closed this duration gap.
One of the favoured strategies to help comply with the FTK was to add a swap overlay to the initial asset allocation. Overlay strategies make it possible to leave the initial portfolio almost unchanged.

By entering into a swap agreement, pension fund managers can receive a fixed long swap rate and pay the floating rate, which narrows the gap in duration between assets and liabilities as reported to the regulator by raising interest rate sensitivity on the asset side.

A common alternative is to use swaptions, i.e., the right rather than the obligation to enter into a swap agreement.

Second, to some extent, the required adjustment in the asset allocation may be achieved by increased contributions and diminished indexation rather than by diminished investment in real assets. After all, increased contributions are equivalent to a loss, which reduces the initial nominal guarantee and thus increases the regulatory funding ratio, which in turn limits the need to reduce investments in real assets during market downturns.

Our view is that when the liability is replicable, the funding requirements can be embedded in the investment strategy, in line with Binsbergen and Brandt (2008) and modern ALM concepts as described in section 3.1. Benefits from investing in equities must be assessed and equity risk must be managed. Practical issues arise when there is more than one constraint, as illustrated in section 4.2.1, where both the volatility of the funding ratio and the prudential funding requirement are taken into account in the definition of the strategy.

Liabilities, of course, are seldom nominal liabilities that are fully replicable without any risk taking with cash instruments. For real liabilities, the replication exercise may involve holding risky assets, before any decision relative to the capital structure of the firm.

When, as in section 3.3.2, we use a more realistic description of long-term pension fund liabilities that involve wage indexation—in the form of traditional pension funds or more modern hybrid pension funds with target wage indexation—equities are used to build the LHP. In addition, replication is feasible only over the long term, so short-termism (maximisation on a short-term horizon) is inefficient.
4.2.1. Monitoring the deviation from the funding ratio and the funding requirement together

Changes in the funding ratio of the pension fund have no impact on the IFRS P&L of the sponsor as long as the funding ratio remains between 90% and 110%. When this corridor is breached, any change in the surplus or deficit in the pension fund does have an impact. The impact may be great, because even though they are amortised these surpluses or deficits can be large relative to the P&L of the sponsor; indeed, the balance sheets of the pension funds sponsored by some older companies may be greater than those of the companies themselves.

So the sponsor of the pension fund, especially if it is a corporate pension fund, should design the ALM strategy in such a way as to keep fluctuations in the funding ratio within this corridor. The British FRS 17 standard does not allow smoothing surpluses and deficits. Any surplus or deficit has a full impact on the P&L of the sponsor; the IAS 19 corridor is not taken into account. In addition, to conform to UK practices, some of the British sponsors that apply IAS 19 rather than FRS 17 do not avail themselves of the default "corridor" option; as a consequence, changes in the funding ratios of their pension funds can have a great impact.

**Minimising the volatility of the funding ratio**

In the UK, the accounting treatment of the funding ratio creates incentives to minimise its volatility. For instance, interest rate exposure may be designed for the sole purpose of limiting the susceptibility of the funding ratio to changes in interest rates, whereas exposure to high-yielding assets may be considered independently of the interest rate exposure.

When the focus is on the P&L, IAS 19 may provide the standard funding ratio, but, as shown in the example below, the regulatory funding ratio may be used to revise contribution rates.

**Example: taking regulatory and accounting constraints into account**

**Box: Duration over-hedging in a Dutch pension plan**

In general, it could be said that the main objectives of most Dutch pension funds under FTK regulations should be to:

1. maximise the expected long-run indexation
2. secure the minimum solvency required by the DNB, i.e., minimise the likelihood of the funding ratio falling below the required solvency level (RSL) in the short run.

As far as duration is concerned, we have seen that fully hedging interest rate liability risk makes it possible to minimise the RSL for interest rate risk by reducing the effect of the interest rate stress test to zero. This reduction would contribute to the second objective by increasing the buffer or excess solvency (difference between current solvency and RSL) and increase the possibility for exposure to risk-seeking assets.

However, another factor that will affect the likelihood of failure to attain the RSL is the volatility of the funding ratio. This volatility is affected by the level of interest rate hedging, and is minimised when the amount of hedging corresponds to the assets, rather than the liability. In practice, this hedging strategy involves investing in the regulatory LHP up to the asset exposure/weight (i.e., 127% of the regulation liability value, as in the equilibrium and starting funding position of the scheme described).
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Let $L$ be the regulatory liability, i.e., a stream of fixed cash flows. The LHP is $L^*$, and can be made of swaps to save cash for liquidity and for the creation of risk-seeking portfolios.

Let $V(A)$ be the asset value, $V(A)>V(L)$. The starting or target position for a Dutch pension fund is usually around 130%.

The funding ratio or coverage ratio, $FR = V(A)/V(L)$

for each maturity $i$ (or each factor of the term structure of interest rates),

$$\frac{\partial FR}{\partial r_i} = \frac{\partial A}{\partial r_i} \frac{A}{L} - \frac{\partial L}{\partial r_i} \frac{FR}{L}$$

and this is set equal to zero for an exposure to the LHP of the funding ratio ($FR$).

The surplus $S = A - L$, on the other hand, is sensitive to interest rate movements. As a matter of fact, where $A = FR \cdot L + O$ (where $O$ has no sensitivity to interest rate changes):

$$\frac{\partial S}{\partial r_i} = \frac{\partial A}{\partial r_i} - \frac{\partial L}{\partial r_i} = (FR - 1) \frac{\partial L}{\partial r_i}$$

Minimising the sensitivity of the funding ratio to interest rates also has drawbacks. For instance, this strategy implies that the surplus has a net duration exposure; in other words, when the funding ratio is insensitive to interest rates, the surplus is a constant proportion of the value of the liabilities, and changes in the same proportion as liabilities do. As a consequence, when the funding ratio decreases (for non-interest rate reasons), this strategy may alter the capacity to take on exposure to the risk-seeking portfolio (equity and other asset classes expected to perform).

On the other hand, whereas minimising the sensitivity of the surplus to interest rates minimises FTK requirements, it too has drawbacks. After all, it could be more of an issue for a corporate sponsor that reports the pension fund under IAS19. Indeed, because variations of the surplus impact the P&L of the sponsor, making the surplus more sensitive to interest rates may be detrimental.

A comparison of the two strategies makes it clear that minimising the likelihood of hitting the RSL would require an amount of hedge greater than the liability and lesser than the assets (or funding ratio * liability).

AXA IM has attempted to quantify this optimal level by using a proxy for likelihood of hitting the RSL, or “distance”: the difference between the current funding ratio and the RSL, divided by the volatility of the funding ratio.

The chart below is a quantitative example using analytics developed by AXA IM. It shows the two factors: the RSL (FTK requirement, in purple) and the funding ratio volatility (in orange). This quantitative example confirms that the RSL is minimised for a hedge up to liability while the volatility of the funding ratio is minimised for a hedge up to assets. The distance is shown in green and is greatest at above 100% which shows that over-hedging (in this example at about 105-110% of the liabilities) is optimal, assuming this distance is a good proxy.

NB: this example is for illustration only and is relevant only to the fund that was used for the case study. This analysis needs to be tailored to the specific funding ratio, risk appetite, asset allocation, and general circumstances of each pension fund.
As illustrated above, the regulatory and the accounting views may coincide. Defining a target based on the volatility of the funding ratio, as opposed to managing under the constraint of a floor value, is important when excess returns penalise the sponsor. Excess returns are penalised when (above a certain funding ratio, for instance) they are no longer tax deductible, or when surpluses cannot be recovered by the sponsors. In the Netherlands, surpluses accrue and pass through to liabilities, and in Switzerland they cannot be recovered at all.

4.2.2. Short-term vs. long-term volatility of the LHP for wage-indexed liabilities

Because pension funds are subject to regulatory and accounting constraints, we will also consider the short-term characteristics of portfolios built for the
long term. We focus on wage-indexed liabilities with maturities of twenty and fifty years because we are interested in the impact of short-term constraints on long-term liabilities.

We have seen that wage growth is the result of past increases in the stock market. Equities, after all, are a leading indicator of the economy and wages a lagging indicator whereas investors buy stocks when they think the economy is growing, companies increase wages when their revenues increase. So exposure to current equity returns will also bring with it future increases in liability value.

The consequence is that with shorter reporting horizons—all intermediate funding reports to the supervisor of the pension fund and IAS 19 reports in the sponsor’s accounts—a significant amount of volatility will be reported.

All graphs below are derived from the model specification and parameter estimates in 3.3.2.

If the pension fund uses the time-dependent hedging strategy, i.e., invests in the TLHP, it is fully hedged at maturity against the unexpected component of equity returns. The black dotted lines shows that the risk arising from the hedgeable equity factor is zero at maturity. While annualised volatility (the measured volatility divided by the square root of the time— in the graph just above, the black dotted line from this hedgeable source of risk falls constantly but not linearly, so the measured volatility is hump shaped, and it rises in the first year before falling to zero.

The forecast error in wages in the co-integration equation is a non-hedgeable source of risk because it is not spanned by existing securities. The volatility from this source of risk is shown by the blue line. It rises progressively toward its peak, 10%. This also means that when measured at an annual rate, volatility from non-hedgeable risk falls with the square root of time.

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Figure 4.8a: A time-dependent hedging strategy for a fifty-year liability
Total pension fund volatility is hump shaped and falls significantly over time.
An interesting issue is whether the risk incurred by a pension fund needs to be measured in accordance with the ALM model that reflects both its risks and the way they are matched, or, by contrast, in a short-term framework.

When measured with an ALM model, the pension fund that uses a pure replicating strategy, without taking any funding or strategic risk, is subject to annualised volatility of 1.4%. If funding requirements are derived from this long-term approach—for instance, if twice the annualised volatility is required as additional funding77—the volatility from the long-term TLHP strategy requires 3% funding on top of the invested wages.

By contrast, when regulations are based on a short-term approach and take the long-term nature of ALM into account only imperfectly, as is most often the case, the volatility taken into account is the short-term rather than the long-term volatility. In this case, with a one-year volatility of 12.5%, the funding requirement for this long-term risk-free strategy is 25%. This 25% is calculated before taking into account interest rate risk, which may require additional funding because of the way it is measured (see section 2.2.4.1).

When the ALM interdependency of equities and stocks is not recognised over the short term, the 93% investment required in the first year may be fully accounted for as a risk-seeking investment in spite of its hedging nature. The funding requirement for these investments is even higher than the 25% mentioned in the previous paragraph.

This requirement penalises the fund and creates incentives to put into place a policy that is risk-free in the short term but very risky over the long term. Here, the incentives are for pension funds to hold between 0% and 12% equities, depending on whether the one-year dependency is recognised by regulation or not.
4. Prudential and Accounting Constraints on Pension Fund ALM

This 0-12% regulatory matching strategy minimises short-term risk but is much less efficient over the long run. As can be seen in the figures 4.8a and 4.8b, short-sighted ALM in the case of wage-indexed liabilities imposed, say, by the regulator or the accountant—can damage the long-term position of the fund.

The figure 4.9a shows that total volatility rises approximately linearly, reaching 65% at the fifty-year horizon. Thus, the annualised volatility rises approximately with the square root of the time, so the pension fund loses any potential benefit from long-term investing and has worse long-term properties than the average short-term investor without liability constraints.

Figure 4.9a: The impact of a short-sighted strategy on wage-indexed liabilities
A short-sighted strategy involves insufficient allocation to real assets—total volatility rises linearly with time because of the risk embedded in liabilities and not matched by the investment strategy.

Figure 4.9b: The impact of a short-sighted strategy on wage-indexed liabilities
The annual volatility of a short-sighted strategy rises with the square root of time over long horizons.
4. Prudential and Accounting Constraints on Pension Fund ALM

Box: The twenty-year case
The very long-term fifty-year wage-indexed liability lets the reader visualise the very long-term behaviour of pension fund investing. It also suggests the investments that should be made for young active members of wage-indexed pension plans. The twenty-year maturity wage-indexed liability may be more representative of the average duration of a pension liability, so we include it for comparison.

The first set of graphs shows cumulative and annualised volatility when the static LHP is used.

Using an SLHP is naturally far less efficient than taking the time-dependent approach proposed in what we call the TLHP, as illustrated by the set of graphs below. The efficiency gain from time-dependent investing is 30% of the volatility (i.e., of the risk budget) over a twenty-year horizon.
By contrast, the third set of graphs (below) illustrates that following short-sighted rules, such as simple annual matching of the current equity delta of wages, is by far the least efficient strategy.

Acting in response to regulatory or accounting incentives leads to a reduction in short-term risk from 9% to 3%, a fall of more than 50%. After all, from an asset-only point of view, reducing the amount of equity holdings means reducing the amount of risk.

However, the amount of long-term risk more than doubles, as the annual volatility of the short-sighted strategy jumps from 2% in the TLHP to 6%, which means that cumulative volatility rises from 9% to more than 25% in the short-sighted strategy.
4. Prudential and Accounting Constraints on Pension Fund ALM

Ideally, as our illustration shows, regulation should focus on creating incentives for pension funds to manage for the long-term benefits of their participants. However, institutional constraints tend to be short-sighted, especially since they focus on the measurement of value rather than on risk measurement and management. This short-sightedness often creates incentives to immunise the balance sheet to very short-term changes in the risk factors rather than to monitor long-term developments.

These incentives are naturally detrimental to the long-term stability of pension funds. After all, the securities that are risk-free in the short term are not those that are risk-free in the long term, and vice-versa.
4. Prudential and Accounting Constraints on Pension Fund ALM

Box: Regulatory constraints and the use of derivatives
The financial risk of wage-indexed liabilities can be shed over the very long term, so from an economic standpoint, equity investments are not risky over the very long term. Because of the short-term volatility in the funding ratio caused by the long-term replicating strategy, regulatory constraints may require action. As we have seen, a short-sighted investment strategy is detrimental to pension funds and their sponsors over the long run. Pension funds must then resort either to a higher funding ratio at the inception of the strategy or to derivatives.

The trade-off between these two options depends on a wide range of factors, including:
• The net cost of borrowing capital for the sponsor
• The frictional costs of investing in options (e.g., the bid-ask spread)
• Whether the shares of sponsor ownership of options and surpluses are equivalent.

In the example below, we suppose that:
• Implied option volatility is equal to the regulatory prescription for volatility (15%).
• Regulation requires that buffers be built against equity holdings, with a weight of 25% (a regulatory prescription based on the idea of a one-year confidence interval of approximately 95%).
• The discount rate is 4%.
• An option is taken on the total return equity index.
• The liability value is €100.

Then, for a twenty-year liability, which requires a €67 investment in equities at t=0, without equity options, prudential regulation requires a €17 buffer. If the net cost of borrowing capital is estimated at 4%, the one-year buffer has a direct cost of €0.7. By contrast, protection with an at-the-money put option for the full equity investment exposures involves an investment of €2.7 in a put option, which obviates the need for regulatory buffers against equity risk. This €2.7 investment has two costs:
• First, it requires an additional €2.7 investment, which, like the buffer, has a cost, here 4% times €2.7, or €0.1.
• We may then suppose that options are overpriced; for instance, bid-ask spreads may be required. In our example, equity index put options are the best possible choice for pension funds and their sponsors as long as options are not overpriced by more than €0.6, i.e., by no more than 22%. In our example, this means that the implied volatility of the put option should be no more than 17.5%, given a market volatility of 15%.

Conclusion
First, tightening accounting standards and prudential regulations require a clearer understanding of the risk management and investment strategies used by pension funds. Greater attention is being paid to the volatility of the surplus, and there is less tolerance of underfunding.

These changes call for an improvement in ALM strategies and the use of state-of-the-art models—such as dynamic liability-driven investments—for the design of these strategies. The constraints to which pension funds are subject must be clearly understood and embedded in the investment strategies:
4. Prudential and Accounting Constraints on Pension Fund ALM

• The impact of the regulatory discount rates for the definition of the portfolio that minimises regulatory risk
• Rebalancing rules that depend on the surplus and are based on insights from dynamic asset allocation concepts and portfolio insurance techniques
• Modelling that captures the specific risk-mitigation mechanisms available to the pension fund, such as conditional indexation, variable contributions, support from the sponsor, modification of asset allocation, support from pension insurance schemes
• Ideally, also, taking into account the negative impact of the probability of sponsor default on the welfare of participants, and hedging this risk
• The practice of risk management, that is, understanding and monitoring the various risk factors faced by pension funds and the design of appropriate responses to changes.

Fortunately, the tools available to pension funds managers are ever more numerous:
• New products have also been launched to supplement ALM techniques and manage more efficiently the risks faced by pension funds.
• New services have emerged to help smaller pension funds manage their assets with state-of-the-art techniques. Fiduciary management, for instance, may provide models to pension funds that do not have the time or capacity to develop their own.

Second, attention should be paid to the long-term nature of pension funds.

In the landscape for savings providers, pension funds stand out for their role as going concerns. In most countries, after all, it is the responsibility of the employer to make good on pension commitments in the event of shortfalls in the pension fund. The long-term relationships between employees and their employers, together with the mandatory participation of employees in their occupational pension plans, relieve pension funds of the risk of client runs and surrenders faced by insurance companies and banking corporations and require monitoring of short-term risk thresholds.

By nature, pension funds can be managed as going concerns, and management should take a long-term view when determining investment policy.

In our view, the replication of wage-indexed liabilities perfectly illustrates the coming challenges for both regulatory bodies and pension funds. As we have seen, pension benefits are indexed either to inflation or to wages. But inflation-linked securities are in short supply, and there is currently no wage-indexed security, so pension funds must find the appropriate assets to hedge inflation risk. Because wages are indexed to the general performance of the economy, real assets, usually equities, are necessary. However, because equities are a volatile, leading indicator of the economy, whereas wages are a lagging indicator, and smoothed at that, replication is possible only over the longer term. That pension liabilities cannot be hedged over the short term makes the importance of taking this long-term view all the greater. As a consequence, and because of their role in providing very long-term benefits, the increasing focus on the short term is worrying for pension funds.
Liabilities that are far more easily replicated over the long term naturally need long-term analyses and risk-management practices. The idea that risk management is best reflected in an internal model is especially relevant for pension funds; after all, no standard formula can capture the diversity of the pension landscape and the variety of protection mechanisms.

As a rule, recent regulation permits the use of internal models, after regulatory approval, for the definition of solvency requirements. Solvency II and the Dutch FTK are no exception, and to some degree UK regulation will extend this approval as well. Approval is primarily conditioned on the use of internal models in the following fields: design of investment strategies, risk monitoring and limit setting, definition of the indexation policy, contribution and funding policy (planning). When these conditions are met, pension funds can align funding requirements and the nature of their risks. Then, when pension funds use risk-mitigation techniques and instruments unrecognised in the standard formula (dynamic strategies, long-term investing), quantitative requirements are reduced.

In a word, accounting and prudential regulations are threatening to make defined benefit pension schemes more costly. Our study concludes that dynamic ALM and internal models may be useful means of warding off this threat.
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5.1. Country Background and Prudential Regulations

For each of the countries of interest (the Netherlands, the UK, Germany, and Switzerland), we will describe country regulation and its impact on ALM.

5.1.1. Dutch regulation is aligned with SII (similar structure, different calibration) and the IORP directive (use of the accrued benefits measure)

The Netherlands is home to the most highly developed pension industry in Europe

The Netherlands is important because it has the most professionally organised pension funds and, relative to GDP, more assets under management than any other country.

The FTK (Financieel Toetsingskader) is aligned with Solvency II and IORP

With the Financieel Toetsingskader, or FTK, the Netherlands has chosen a regulatory framework with the same modular approach as that of SII. Although it applies to both insurance companies and pension funds, the two industries are treated differently. The FTK for pension funds is less demanding in terms of capital, because of both liability valuation and lower calibration.

Like SII and Basel II, the FTK is organised into three pillars, the first of which has to do with quantitative requirements, the second

Most of the 800 pension funds are still open, although some smaller sponsors have had their pension funds bought out, then provided their employees with insurance policies to comply with rules for mandatory participation in the occupational pension system. Administrative burdens imposed by new regulatory and accounting standards and the desire to shed long-term legal liability led to these sales.

Figure 5.1: The Netherlands has the highest second-pillar pension commitments relative to GDP

![Graph showing pension commitments relative to GDP](image-url)
with risk management, and the third with reporting and disclosure. More precisely, the FTK requires:

First Pillar
Valuation principles are fair value accounting, with assets fully accounted for and marked to market.
For liabilities,
- Accrued benefits are the measure that matters, so only unconditional indexation is taken into account.
- The discount rate is the Dutch zero-coupon yield curve, a significant change from the previous 4% fixed discount rate.
- A market value margin for non-hedgeable risks was to be applied but in the final version, the MVM is omitted in favour of the more traditional principle of prudence, with the mandatory use of a prospective and prudent mortality table.

Two levels of solvency requirements that must be tested every year:
- A minimum funding ratio of 105%. The Dutch National Bank (DNB) must be informed immediately of any shortfall and a subsequent strategy must be developed within three months to restore the funding ratio above 105% within three years. This usually involves higher contributions, then a revision of indexing rules. Benefits may be revised downwards only when the sponsor has capped its maximum contribution in the pension scheme.
- A solvency test calibrated over a one-year risk horizon. The assets must be high enough (105%) to cover the liabilities over a one-year horizon with a probability set at 97.5%. Three versions of this solvency test are proposed by the FTK regulations:
  - A simplified method: the funding ratio must be greater than 130%, and no more than 25% of the assets may be invested in equities. This system is recommended for small pension funds.
  - A standard method: this is the FTK-recommended model for evaluating the solvency requirement. As in SII, it involves a modular approach. Six risk types, referred to as S1 to S6, are taken into account in the FTK, with risk charges resulting from the impact of pre-defined market stress scenarios, as in SII (and in the FTK as applied to insurers).
    - Interest rates and inflation are combined in S1; for pension funds the relevant scenario is a rise in interest rates (a rise of 24% in long-term bond yields, and of up to 54% for the one-year bond yield) and a rise in inflation 30% above market expectations (e.g., from 2% to 2.6%).
    - In S2, a scenario of a 25% fall in mature shares and a 30% fall for emerging markets and private equities, as well as a 15% fall in real estate.
    - Insurance and actuarial risks are measured in S6, with volatility risk the primary consideration. Trend risk (or the risk of increased longevity, is supposedly implicitly taken into account with a prudent mortality table.
    - An additional concentration risk charge may be levied for insufficiently diversified portfolios.
  - Other risk types: in S3, exchange rates fall by 20%; in S4, commodities fall by 30%; in S5, credit spreads widen by 40%.
  - The solvency requirement is calculated by aggregation of the six risk charges, as follows:
    \[
    Total = S_1^2 + S_2^2 + 2 \cdot \rho \cdot S_1 \cdot S_2 + S_3^2 + S_4^2 + S_5^2 + S_6^2
    \]
    With \( \rho = 0.65 \) All other correlations are assumed to be zero.
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• An internal model method: pension funds can use an internal capital adequacy model to evaluate the required shareholder's equity in order to achieve the solvency requirement (97.5% Value-at-Risk over a one-year horizon).

When the buffer is too low (coverage ratio of less than around 130% under the simplified method, a correct approximation for a standard pension fund under the other two methods), pension funds should present a recovery plan to the supervisor aiming for recovery in at most fifteen years. Interestingly, expected future returns on the investment strategy may contribute to restoring the target funding ratio, a feature that may help pension funds stick to their long-term strategic allocation during downturns–if pension funds view the downturn as the result not of a more pessimistic outlook for companies but of a rise in the market risk premium.

One may note that:
• Both solvency tests apply only to guaranteed (in practice, nominal) pension rights.
• There are no quantitative investment limits; by contrast, diversification is required by law.

Second Pillar
In addition to the two solvency tests of pillar I, a "continuity test" is required as part of pillar II. It involves a projection of capital requirements that serves to manage risk as well as to set the future contribution levels and likely indexation rates that are communicated to employees. Pension funds must provide evidence to the supervisor that their funding and investment strategy are consistent with their indexation ambitions; unconvincing evidence may result in additional capital requirements (to pillar I calculations).

Third Pillar
The third pillar has resulted in increased transparency and financial communication for Dutch pension funds. It obliges pension funds to inform scheme members of their indexation policies. Pension schemes will have to state explicitly whether or not the pensions are indexed, and if so, what system is used. Based on the continuity analysis, they must inform their participants in explicit terms about their indexation ambitions.

---

Table 5.1: Similarities and differences between FTK and other standards.

<table>
<thead>
<tr>
<th>Theme</th>
<th>FTK for pensions</th>
<th>IORP</th>
<th>SIU/FTK for insurers</th>
<th>IAS 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pillar I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valuation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method</td>
<td>Accrued benefits</td>
<td>Accrued benefits</td>
<td>&quot;Best estimate&quot; implies projected benefits</td>
<td>Projected benefits</td>
</tr>
<tr>
<td>Market value margin</td>
<td>Omitted in the final version. Prudent mortality table used instead.</td>
<td>NO</td>
<td>YES (cost of borrowing regulatory capital)</td>
<td>NO</td>
</tr>
</tbody>
</table>

81 - The Pension Act also stipulates that conditional indexation must ensure that the expectations raised, the financing, and the realisation of the conditional indexation are compatible.
### 5. Appendices

<table>
<thead>
<tr>
<th></th>
<th>Discount rate</th>
<th>Government bond yields/swap rates</th>
<th>Prudence required</th>
<th>Swap rate [in previous versions, government bonds]</th>
<th>AA rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantitative requirements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach</td>
<td>Modular (identical to Solvency II)</td>
<td>(not defined)</td>
<td>Modular, by means of scenario analysis when possible</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td><strong>Levels of capital</strong></td>
<td>2 [min, target]</td>
<td>1 (min)</td>
<td>2 (min, target)</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td><strong>Calibration of minimum reqs.</strong></td>
<td>105% funding ratio</td>
<td>100% funding ratio</td>
<td>90% VaR</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Min reqs. not met</strong></td>
<td>3-year recovery period</td>
<td>&quot;concrete and realisable&quot; recovery plan</td>
<td>bankruptcy</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td><strong>Calibration of target reqs.</strong></td>
<td>Solvency Stress Test: 97.5% VaR</td>
<td>-</td>
<td>Solvency capital requirement: 99.5% VaR</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Target requirements not met</strong></td>
<td>15-year recovery period with allowance for financial returns</td>
<td>-</td>
<td>Length not defined, but action required.</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Future contributions from new business</strong></td>
<td>Not recognised in Pillar II</td>
<td>(Not mentioned)</td>
<td>Not recognised</td>
<td>Not recognised</td>
<td></td>
</tr>
<tr>
<td><strong>Risk-mitigation</strong></td>
<td>No reduction for profit sharing (RPS)</td>
<td>(Not mentioned)</td>
<td>Reduction for profit sharing (RPS) when conditional indexation can be reduced (no sponsor but external guarantee may be valued)</td>
<td>No risk measure required</td>
<td></td>
</tr>
</tbody>
</table>

#### Pillar II

| Incentives for risk management | Align with SII plus a specific continuity analysis including future premiums | - | Yes | - |

#### Pillar III

| Communication | SII plus specific communication guidelines for employees on the indexation policy pursued and expected indexation for employees | - | Solvency positions Details undecided | - |

---

**The FTK: a nominal framework for real liabilities**

New regulations triggered changes in indexation rules, and make pension funds more similar to insurance companies (but still more flexible). The Netherlands provides an excellent example of how regulations are a driving force behind pension plan designs, or of how the pension industry can adapt to new regulations. The pension fund industry has reacted to these new regulations by forgoing...
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formal indexation and replacing it with conditional indexation, a mechanism not unlike profit sharing in insurance companies. What is unique to the Netherlands, as described below, is that as a consequence of changes in indexation the pension fund industry faces a paradox that may have great consequences on ALM: pension funds report liabilities to the regulator as if they were nominal fixed cash flows. Nevertheless, the target liability is a real liability, as pension funds aim to maintain wage indexation as they have always done, independently of regulatory changes.

The FTK prescribes stricter solvency requirements for guaranteed or nominal pension rights than does regulation in most other countries. By asking for full funding plus buffers against investment risks, it virtually ignores the role of the sponsor in providing or contributing over the long term to guarantees made to employees, and makes it very difficult to offer indexation guarantees at a reasonable price. On the other hand, much more flexibility is given regarding conditional rights (such as indexation), because these rights are not accounted for in the statutory value of the liability.

Though unconditional indexation of pension benefits used to be served unconditionally every year, guarantees were not always written into contracts. So indexation was often temporarily halted during the 2001-2003 stock market crisis. As required by the FTK, it was pointed out to employees in no uncertain terms that “the indexation of your pension is conditional; there is no entitlement to indexation and, over the longer term, it is also uncertain whether there will be indexation or its extent” (3.30, paragraph 15).

With conditional indexation, the liability value diminishes markedly. In other words, making indexing conditional on the funding ratio of the pension plan naturally makes it possible to avoid announcements that the pension fund is unable to meet its commitments.

Both indexation targets (which influence replicating assets) and indexation rules (which make clear that indexation depends on the funding ratio of the pension fund) are specific to each pension fund. In many cases, indexation is halted when the funding ratio falls toward 105% (or a somewhat higher floor); full indexation takes place only when the funding ratio is above the solvency stress test (or a closely related cap). In addition (especially if full indexation was not provided in some of the previous years), the lag may be made up or contribution rates may be slightly reduced.

FTK, based on ABO, is a nominal framework, applied to real liabilities. The move toward conditional indexation was instrumental to the prosperity and solidity of the Dutch pension fund industry.

This situation was allowed by the regulator. However, it creates a divergence between the regulatory reporting and the internal views of the pension funds.

When reporting to the regulator and making statutory funding calculations, the liabilities are computed as ABO (accrued benefit obligation), as fixed cash flows. As a consequence, the statutory duration of the liabilities is very long.

As capital is required to cover interest rate risk, calculated in S1 as the change
In net asset value (assets minus liabilities) subsequent to an interest rate shock, long dated nominal liabilities require a bond portfolio of very long duration.

Indexation was made conditional mainly for reporting purposes, but most pension funds have an indexation target over the long run. As a consequence, their internal view is that they hold real liabilities. A discussion summarising the duration of pension liabilities with conditional indexation can be found in section 4.3.2.

So the internal view is that duration is in fact much shorter than that reported to the regulator, and that fully closing the regulatory duration gap creates risk from an economic standpoint, even though it reduces solvency capital requirements. With respect to indexation, the reverse is also true: hedging the sensitivity to future indexation would create additional capital requirements but would decrease economic risk. Equities, which, as we shown in section 2.3.2, are a good fit for long-term economy-indexed real liabilities, are reported as mere risk-taking assets rather than as the replicating assets they actually are; as a consequence, investments in equities increase capital requirements.

The FTK is a challenge for ALM managers. The ALM constraints are complex, and depend on the initial funding of the pension fund. The FTK, as a short-term funding constraint, is not always straightforward to implement because of the contradiction between the funding measure used for the long-term target (in the continuity analysis) and that used for the short-term funding constraint.

Because of changes in pension plan design, risk as measured by the FTK is a misleading indication of the real risk embedded in the pension plan.

Poorly funded pension plans cannot always maintain target indexation. Wage indexation is generally achieved in the long run by investing in equities (see section 3.3.1 of the current study). However, under FTK rules a 40% investment in equities raises funding requirements by 10%, to at least 120%.

Pension funds with low funding ratios (and little capacity to raise contributions swiftly) cut their equity exposure, and swap it for long duration risk-free bond exposure. That, in turn, means employees lose the initial target indexation to wages and equity performance.

As a consequence, for the least well funded Dutch pension funds, new accounting and regulatory standards may not be beneficial to members, who though they gain the security of benefits lose all upside potential.

As a whole, the Dutch pension industry was better funded than, for instance, its counterpart in the UK, where it would have been downright impossible to enforce such stiff regulation.

Large and well funded pension plans can maintain their long-term strategy. Some of the largest multi-employer schemes had funding ratios sufficiently high to leave pre-FTK asset allocation unchanged. For a very limited number a halt to indexing and an increase in contributions have always been sufficient tools, and post-2003 equity performance made it possible to make up for the
halt and reach the pre-2003 indexation target.

As long as reserves are sufficient, long-term goals can be safely pursued.

The intermediate situation requires lengthening the duration of the bond portfolio.
Naturally, most funds are somewhere between these two extremes, usually with sufficiently high funding ratios to withstand a pronounced allocation to risky assets, but as they have used the standard formula for capital requirements, they have had incentives to narrow the regulatory duration gap. Swaps have been used to lengthen the duration of the portfolio, and risk exposure has been slightly reduced.

More detailed illustrations are provided in chapter 3.

5.1.2. Modern and flexible regulation of pension funds in the United Kingdom

The UK is home to a very large and largely underfunded pension industry.
After the Netherlands, the United Kingdom has the largest per capita pension industry in the European Union. The new regulatory framework, which will be described below, is flexible compared with Dutch regulations, and, in an attempt to foster the development of funding strategies that are appropriate to the circumstances, it aims to be fund-specific as well. Although this flexibility is certainly desirable from a theoretical point of view, it is likely that its prominence as a feature of British pension regulations is a result of entirely practical considerations; the British pension fund industry, after all, was in poor shape after the perfect storm of 2002.

This poor shape is partly the result of previously weak funding regulations and of confusing or even competing tax-related maximum funding constraints. This situation was instrumental in letting sponsors and employees take contribution holidays in the 1990's, when financial returns were good (and higher bond yields diminished the value of the liabilities).

The new prudential regulations, introduced by the Pensions Act 2004, have resulted in far greater security for member benefits... when pension funds remain open, that is. The conservative requirements of FRS 17,84 following the extended bear market of 2000-2002, with lower gilt yields, lower equity prices and return expectations in general, have contributed to the continuing withdrawal of employers from the provision of last-wage pensions and of DB schemes in general. The increasingly heavy burden of new regulations on management was a concern for the vast majority of employers running small DB schemes and has also contributed to this ongoing withdrawal.

Box: The state of the British pension system
According to the purple book, published by the Pension Regulator85 in 2007, and based on the findings of a panel that represents 93% of DB schemes and 97% of DB liabilities, as of 31 March 2008:
• Most schemes are closed; open schemes make up 31% of schemes in the sample but represent 44% of total memberships, as larger schemes are more likely to remain open. The broad trend is toward opening DC schemes.

---

84 - FRS is similar to IAS 19 for estimates of the value of assets and liabilities, but it is more restrictive for the calculation of the impact on P&L, as, unlike IAS 19, it does not allow the smoothing of the volatility of assets and liabilities.
85 - Charts are also taken from the Pension Policy Institute (PPI).
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- From the Pension Protection Fund data, in December 2008, 89% of schemes were running deficits, with an aggregate deficit of £209bn: 11% had surpluses, with an aggregate surplus of £15bn. Only the largest funds have significant surpluses.
- By far the largest proportion of assets is in equities (54%) followed by gilts and fixed interest assets (33%). In addition, small schemes have insurance policies as assets (to cover longevity risk).
- Equity exposure has decreased and duration increased since the mid 1990’s. But schemes still have short duration exposure and long equity exposure: a 0.1% increase in gilt yields reduces aggregate scheme underfunding by around £15bn. A 2.5% rise in equity prices reduces scheme underfunding by around £11bn. An increase in equity markets of nearly 50% would be needed to eliminate the deficit, as would a 140 basis point rise in gilt yields.

Asset allocation: simple averages

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equities</td>
<td>52.6%</td>
<td>53.5%</td>
<td>50.6%</td>
</tr>
<tr>
<td>Gilts and fixed interest</td>
<td>22.6%</td>
<td>24.0%</td>
<td>26.7%</td>
</tr>
<tr>
<td>Insurance policies</td>
<td>14.9%</td>
<td>13.7%</td>
<td>12.8%</td>
</tr>
<tr>
<td>Cash and deposits</td>
<td>3.9%</td>
<td>3.7%</td>
<td>4.4%</td>
</tr>
<tr>
<td>Property</td>
<td>2.1%</td>
<td>2.5%</td>
<td>2.9%</td>
</tr>
<tr>
<td>Other investments</td>
<td>3.6%</td>
<td>2.6%</td>
<td>2.6%</td>
</tr>
</tbody>
</table>
Minimum funding requirements (MFR) were lax; the new scheme-specific funding (SSF) requirements are more demanding

MFR: the first funding requirements were lax

The first funding requirements made of British pension funds were introduced in 2002 and known as minimum funding requirements (MFR).

Despite the name, the aim of MFR was not so much to set cast-iron funding requirements as to prevent fraud of the sort perpetrated by Robert Maxwell. As a matter of fact, MFR allowed the use of optimistic financial assumptions that meant that funding requirements were lax:

- The inflexible nature of prescribed requirements meant that the assumptions underlying the calculations were not kept as up-to-date as would have been ideal, because keeping them up to date required government approval.
- In particular, the assumption of fixed long-term market returns of 10% per annum for active members (less 1% pa for expenses), and 8% pa for pensioners, though at the time close to past financial conditions, were overly optimistic and rapidly deviated from any realistic return. The mortality assumption was also prescribed, but increases in life expectancy soon made it too obsolete.

After the IORP directive the MFR was replaced by scheme-specific funding (SSF) requirements.

By the time MFR had been applied in the UK, the European Parliament had adopted the IORP directive 2003/41 EC, requesting translation into national law by 2005. As a consequence, the British regulators modified the Pensions Act 2004 in 2005 and changed the legislation from minimum funding requirements to scheme-specific. When SSF replaced the MFR, the MFR had clearly become a weak requirement, and the new regime, though flexible by European standards, is more demanding than its predecessor.

SSF sets as a target the full funding of accrued benefits.

Though many pension funds use PUC for funding requirements, either under the influence of accounting standards or for their own targets, the legislation (as described in the code of practice) requires that the accrued benefits funding method be used. In particular, every scheme will be subject to a statutory funding objective (SFO): a scheme must have sufficient and appropriate assets to cover its technical provisions. In practice, pension schemes are free to set their own technical provisions, so the SSF requirements may be viewed as (an incentive toward) supervised self-regulation.

SSF requires more prudent valuation hypotheses than MFR.

Unlike MFR, which allowed the use of outdated valuation hypotheses, scheme-specific regulation specifically requires a prudent choice of actuarial assumptions or discount rates; they are not prescribed.

The regulator states, for example, that “it is not imprudent to assume that, depending on the circumstances of the scheme, its assets could outperform bonds. In particular, the trustees should consider the scheme’s investment policy and the ability of the employer to cope with the financial consequences of assumptions not being borne out”.

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86 - Both IAS 19 and the British-equivalent FRS 17 require valuation on a PBO/PUC basis.
87 - Pension funds are obliged to report a scheme-specific statement of funding principles (SSF). This statement describes the methods and assumptions used by the fund to calculate the liabilities; they must also base future funding contributions as well as any recovery plan on these principles.
88 - Trustees set the TPs after taking advice from their actuary and (except where the scheme’s own rules give unfettered power to the trustees to set contributions) after obtaining the sponsoring employer’s agreement.
Developments in accounting (IAS 19/FRS 17), explicitly used as a point of reference (see below), are nonetheless influencing the adoption of stricter valuation hypotheses for last-wage pension plans. In addition, when calculating the technical provisions the trustees must take into account the actuary’s estimate of the solvency of the scheme on a buy-out basis (the assets required to transfer liabilities to another pension scheme or by buying immediate and deferred annuities), another strict valuation hypothesis.

SSF requires a recovery plan when the regulatory funding target is not met. When the SFO is not reached, the trustees must put in place a recovery plan that specifies the date by which the objective will be reached. The plan must be in place within fifteen months of the effective date of the actuarial valuation. Though the code of practice includes guidelines, it does not stipulate that recovery be complete by any particular time.

Trigger points for further scrutiny made public.

Valuations must be prudent. For its part, the regulator benchmarks the fund’s technical provisions to two alternative published versions of technical provisions: SF179 (minimum reserve guaranteed by the pension protection fund) and the IAS 19 (or FRS 17 if IAS 19 is not reported) projected measure of liabilities. Depending on plan characteristics, it defines a threshold somewhere between these two values to identify funding plans that merit a closer look, and it challenges the funding plans of schemes that breach this threshold.

The requirements as to the suitability of recovery plans are reviewed when the recovery period is longer than ten years. Concerns will be communicated to the schemes (usually the trustees and their advisers but often to employers as well). In last resort, if the regulator is still not happy with the plans, it will seek changes. The average recovery period is 7.5 years.

Participants are protected by the pension insurance scheme, and underfunded pension funds pay a levy proportional to the lack of funding times the risk of default of the sponsor. The flexibility in funding requirements (British regulation allows temporary underfunding), designed to allow currently underfunded pension plans to remain open, is accompanied by a pension insurance scheme, organised by the Pension Protection Fund (PPF). The pension protection levy consists of scheme-based and risk-related pension protection elements. The risk-related element accounts for 80% of the total raised; the rest is essentially a size-related administrative levy. This risk-based element takes into account the funding level of a scheme and the insolvency risk of the sponsoring employer:

The administrative scheme-based levy (SBL) is a function of the SF179 liability (a market-consistent estimate of the minimum accrued liability). For 2007/08 it was set at 0.016% of total pension liabilities, set so that the SBL would account for 20% of the total levy.

The risk-based levy (RBL) takes the section 179 underfunding of a pension scheme as the risk of the sponsor’s insolvency:

\[ RBL = \min (U \times P \times \text{Levy Scaling Factor} \times 0.8, \text{cap} \times L) \]

---

89 – Some pension funds have adopted internal principles that are tighter than IAS 19/FRS 19, because they use the projected benefit obligation, discounted with government yields rather than AA corporate yields.

90 – The FRS 17 measure of pension liabilities may have lost relevance recently as (because of rising AA yields in 2008) it actually fell below the SF179 minimum liability (so British pension funds reported a surplus under FRS 17, but a large deficit under SF179).
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- $U = A/L$ is the underfunding under section 179 rules, making allowances for any contingent asset arrangements and deficit reduction contributions that have been certified to the Board.
- Section 179 requires the calculation of protected accrued benefits. It is a market-consistent estimate of the minimum accrued liability.
  - SF179 values the liability as guaranteed by the pension protection fund: benefits of those members under normal pension age are reduced by 10%, and indexation applicable to benefits granted before 6 April 1997 is disregarded.
  - The mortality imposed is prudent as it includes mortality improvements, and liabilities are discounted at the risk-free rate.\(^{91}\)
- P is the probability of insolvency of the sponsoring employer or employers, taking into account the scheme structure. It is based on Dun & Bradstreet’s failure scores. D&B does a statistical analysis of company balance sheet and P&L data of all sponsors with DB schemes, and in effect serves as a rating agency.
- The levy scaling factor is 2.47. The Board’s levy estimate for 2007/08 is used to calculate this scaling factor to help ensure that the levy collected broadly matches the levy estimate.

The risk-based element of the levy is capped to protect the most vulnerable schemes. For 2007/08 this cap is 1.25% of section 179 estimated liabilities.

On the other hand, healthy schemes generally need to pay the administrative part of the levy in addition to a residual risk-based levy. The risk-based levy is excessive for last-man-standing schemes, as a result of anomalies\(^{92}\) in the assessment of their strength.

**Annual increases in the pensions**
To reduce the burden on DB pension schemes, the Pension Act of 2004 provided for the limited price indexation cap to decrease from 5% to 2.5%. The measure is meant to help offset the costs of the levy imposed by the PPF.

A summary of the caps (maximum) on indexation of benefits is provided below (source: the Pension Regulator):

<table>
<thead>
<tr>
<th>Type of scheme</th>
<th>Service before 6 April 1988</th>
<th>Service between 6 April 1988 and 5 April 1997</th>
<th>Service between 6 April 1997 and 5 April 2005</th>
<th>Service after 5 April 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defined benefit</td>
<td>Nil</td>
<td>3% LPI guaranteed minimum pensions (GMPs)</td>
<td>5% LPI</td>
<td>2.5 per cent LPI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nil on excess</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defined contribution</td>
<td>Nil</td>
<td>3% LPI on protected rights (unless benefits start after 5 April 2005, in which case nil)</td>
<td>5% LPI (unless benefits start after 5 April 2005, in which case nil)</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nil on excess</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

91 - The rate does not depend on the duration of the liabilities; it is prescribed and thus can be considered over-specified. For instance, pensions in payment without indexation are discounted at the ten-year bond yield.

92 - “Last-man-standing” multi-employer schemes benefit from a 10% reduction, while in practice the real probability of default is closer to that of the healthier sponsor than to that of the average sponsor. A single sponsor with zero probability of default (e.g., the state) fully ensures that guaranteed benefits will be paid out, whatever the rating of other sponsors participating in the last-man pension plan. In other words, in a last-man plan, the last survivor provides guarantees in place of those that fail. You will be better protected by one firm that will survive and one that you know is about to go bankrupt than by two firms that each have a 50% probability of going bankrupt, because if the two probabilities are independent, you have a 25% chance of the two sponsors failing at the same time and your being left with no protection.
Impact of Regulations on the ALM of European Pension Funds - January 2009

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Consequence for ALM: the cost of underfunding equivalent to the cost of borrowing capital to remedy it

We view the risk-based levy, in the main, as equivalent to the cost of closing any underfunding by borrowing short-term capital (at a price determined by the sponsor’s credit rating). After all, were access to liquidity granted at all times, the cost of borrowing capital would also be linked to the probability of default of the sponsor and to the amount borrowed, i.e., the shortfall in the event that full funding is required each year. However, paying the risk-based levy as part of the British pension insurance scheme allows sponsors to get around the possible funding and liquidity constraints they would face if they were required to eliminate any underfunding.93

For this reason, British prudential regulations tolerate such long-term strategies as matching last-wage pension plan liabilities with equities, strategies with short-term volatility that may lead to short-term underfunding (FRS 17, however, is more exacting).

The use of an equity risk premium to discount liabilities may in some cases be a trap, as shown in section 2.2.4.c. In the UK, though, risk is perhaps limited because funding requirements are flexible; however, underperforming equity markets at the turn of the century hit British pension funds severely.

5.1.3. Germany has relatively stiff regulation with valuation principles aligned with Solvency I

Germany has traditionally used book reserve systems for occupational pensions

Traditional occupational benefits have been provided through book reserve systems, i.e., systems in which the balance sheet of the plan sponsor contains reserves or provisions for occupational pension plan benefits. Some assets may be held in separate accounts for the purpose of financing benefits, but they are not legally or contractually pension plan assets. In other words, machinery and investments may be financed out of pension liabilities. This system is accompanied by a pension insurance scheme that was founded in 1974, the PSVaG. PSVaG operated like a mutual insurance company; indeed, until 2006 it operated as a pay-as-you-go system (surviving pension funds may need to adjust their contributions to pay liabilities left by bankrupt companies). Upon bankruptcy of the sponsor, it purchases annuities from a consortium of life insurance companies.

This traditional book-value reserving system has been praised for its contribution to financing the investment of businesses and at the same time to guaranteeing the payment of benefits in the event of sponsor bankruptcy.

German firms, of course, must accrue pension liabilities in their local and international statements, but tax deduction of unfunded accruals is allowed whether pension liabilities are set aside in a separate vehicle or kept on balance sheet.

Historically, then, German employers were neither compelled nor given tax incentives to build up external pension funds, a situation

93 - The calculation could nonetheless be refined. An audit is underway at the Pension Protection Fund.
again radically different from that in other European countries. As a consequence, the typical balance sheets of German companies differed greatly from those of companies in other countries.

**Contractual Trust Agreements (CTAs)** are external pools of assets, treated as such by IAS 19 but considered book reserves by the regulator.

The regulatory landscape changed in the 1990’s under the influence of large companies that desired IFRS-compliant and tax-effective funding vehicles.

Book-reserve pension plans are sub-optimal under international accounting standards. Keeping assets on the balance sheet leads to much higher volatility in P&L than having externalised assets and funded pension liabilities, as accounting standards permit no smoothing.

CTAs were created by the private sector to allow earmarking assets for accounting purposes, and they were recognised under German tax law as on-balance-sheet items available for book-reserve pension plans; a discount rate of 6% can be used to calculate the tax deduction (plus a contribution of approximately 0.3% of statutory liability to the PSVaG insurance). CTAs are therefore recognised as funding vehicles for accounting purposes only, but, unlike *Pensionskassen* and *Pensionsfonds*, they are not regulated as real external pension funds (see below).

Most Dax30 companies have adopted this accounting scheme, for an average funding ratio of between 60% and 65%.

**Pensionsfonds** were created in 2002 on the accounting model of insurance companies, but in accordance with the upcoming IORP directive. German *Pensionsfonds* are regulated legal entities separated from the sponsoring employer and offering direct entitlements to lifelong pensions. The sponsor may provide guarantees to the employees or have pension funds (partly) responsible for them: the sponsor remains the first line of defence if the contributions it has made are not paid out.

The discount rate used both for financial and tax statements is 2.25%. It is much lower than the 6% rate applied to CTAs, and contributions are more tax-efficient. However, the low discount rate puts technical provisions for guaranteed benefits on the high side of the European range.

**Pensionsfonds (the German-type pension funds) were created in 2002**

For book-reserved pension plans and CTAs, tax deduction for funding (to the balance sheet or externally), as calculated under the German Teilwert act, is based on a discount rate of 6% and makes no allowances for future salary and pension (inflation indexation) increases. This contrasts with the IFRS calculation, which uses an AA yield for discounting (lower than 6% at least until 2008) and the projected measure (higher end benefits). Overall, it turned out that tax-deductible contributions were much lower than the cost of providing pensions under IAS 19. Companies that had complied with the tax code to establish contributions often reported underfunded pension liabilities, reports that led to negative perceptions in international markets.

94 - Technically, the entry age normal actuarial method is applied.
5. Appendices

Box: Pensionsfonds are German pension funds

Pensionsfonds, created in 2002, are regulated by the German Act on the Supervision of Insurance Undertakings (Insurance Supervision Act—VAG), even though they are different from insurance companies.

General characteristics

- They must offer lifelong retirement benefits (with an allowance for 30% of the accumulated savings paid out as a lump sum at retirement). They may make the mortality table used for the conversion rate equal to the official table proposed by the association of actuaries at the date of inception of the guarantee or at retirement age, when accumulated savings are transformed into annuities. The longevity risk is then shared by plan members. Pensionskassen, by contrast, must use the table at date of inception.
- They guarantee plan participants a right to the benefits: the employer guarantees the payment of the retirement benefits in the event of bankruptcy of the pension fund.
- Pensionsfonds offer a great degree of freedom in investment matters. Bound solely by the prudent man rule, not by quantitative restrictions, they are free to determine their investment strategies.
- Though they must be fully funded, a temporary 5% lack of funding is tolerated.

Valuation of assets

- Bonds receive a typical Solvency I "asymmetric book value" treatment. Unrealised gains can be accounted for at the discretion of the pension vehicle, but unrealised losses are not accounted for.
- For equities (and other risky assets), unrealised capital gains increase the funding ratio—in Germany the regulator cannot oppose the decision to take these gains into account. Unrealised losses on equities require additional reserves, a form of market value adjustment. Put simply, equities are, in essence, accounted for at market value.

Discount rate for liabilities:
- The discount rate used for pension funds, like that used for insurance companies, is based on the technical rate describe in the third Life Insurance Directive 2002/83/EC, Article 20, Establishment of technical provisions. In Germany, this rule is implemented as follows: the technical rate for discounting guarantees is equal to 60% of the ten-year average eight to ten-year bond yield, 2.25% from 2007 onwards.
- Unique in Europe is the low discount rate for technical provisions when the sponsor remains the first line of defence.

Main products: The two main product constructions are as follows:
- Traditional guarantees: each sum invested translates into a mathematical reserve, which is increased by the guaranteed rate, if there is one, and by profit sharing. At retirement age, the accumulated savings are converted into an annuity (which may be further increased by profit-sharing). This is very similar to a classic single-premium insurance product and is the solution of choice when the employee is the main contributor to the pension fund.

95 - The rate of interest used shall be chosen prudently. It shall be determined in accordance with the rules of the competent authority in the home Member State, applying the following principles:
   (a) for all contracts, the competent authority of the assurance undertaking’s home Member State shall fix one or more maximum rates of interest, in particular in accordance with the following rules:
      (i) when contracts contain an interest rate guarantee, the competent authority in the home Member State shall set a single maximum rate of interest. It may differ according to the currency in which the contract is denominated, provided that it is not more than 60% of the rate on bond issues by the State in whose currency the contract is denominated.
96 - It was lowered from 3.25% in 2003 to 2.75% in 2004.
97 - In Germany the sponsor is more usually referred to as the employer.
98 - However, one must keep in mind that Pensionsfonds guarantee plan participants a right to the benefits.
5. Appendices

- Guarantee on accumulated savings by means of a regular premium product. In this case, Pensionsfonds (and their sponsors) can deliver a product without any guarantee if they decide that the premiums needed to achieve the guarantee are variable and may be increased if assets perform badly.
- For the regular premium products, the technical provision is the difference between the discounted value of the guarantee and the discounted value of the future premiums.
- When future premiums are defined in advance, the contract has a guarantee and all future cash flows must be discounted at 2.25%.
- When future premiums may offset poor performance of pension fund investments, future cash flows may be discounted at a market rate, so the pension fund is always funded when, as a result of unfavourable markets, it raises the premium to cover the guarantees.
- For these reasons, this regular premium contract is preferred by sponsors when they are the main contributors to the pension fund.

**Pensionskassen are insurance companies**

Premiums to Pensionskassen, insurance companies specialised in providing retirement, are tax deductible. As insurance companies, Pensionskassen are subject to insurance regulation, currently Solvency I. They will naturally be subject to SII when it comes into force. To ensure a smooth transition, BaFin is gradually introducing stress tests. Pensionskassen provide one part of the benefits in the form of interest rate guarantees and another in the form of conditional profit sharing.

As assets are subject to quantitative restrictions, and as underfunding would mean going out of business, Pensionskassen are highly averse to risk and have little equity exposure.

Unlike Pensionsfonds liabilities, Pensionskassen liabilities are not covered by the PSVaG insurance scheme. As institutions that underwrite pension liabilities to cover against biometric and financial risks, they are subject to higher funding requirements; as insurance companies, lack of available capital leads to termination of the business and transfer to a third party willing to run off commitments.

Nor can Pensionskassen rely implicitly on future sponsor and employee support by issuing contracts of the revisable premiums sort.

It is for this reason that this fully external vehicle tends to be preferred only by smaller businesses that do not want to run the biometric risks themselves.
5. Appendices

The evolution of the accounting and funding requirements for Pensionsfonds is unresolved

As we have seen, SII will apply to insurance companies from 2012 onwards. Though unfit for pension funds, it is tempting to apply at least part of this set of regulations to Pensionsfonds. Valuation standards will probably be harmonised, but funding requirements for Pensionsfonds must be more flexible, in line with the IORP directive. The pension industry hopes that any changes will ease current funding constraints, which are demanding in Germany—especially for younger Pensionsfonds: as no indexation of active members is required and the conversion rate may be defined at retirement date, the 2.25% discount rate appears demanding.

Summary of regulatory constraints on the ALM of German pension funds:

The asymmetric treatment of bonds is an incentive to have a net short ALM interest rate sensitivity. The asymmetric treatment of unrealised fixed-income gains and losses is typical of Solvency I for insurance companies. This is the result of two factors:

- Bond gains are added to equity while losses are not subtracted in the calculation of the funding ratio.
- The liability discount rate is almost fixed and predictable, so changing market conditions have almost no impact on liability value.

The funding ratio is therefore overestimated when interest rates fall, and underestimated when market rates rise. Even when considering that unrealised losses on fixed-income instruments require an asset and liability adequacy assessment, there are incentives to build fixed-income portfolios that have a shorter duration than that of (annuity-like) liabilities.

If a five-year bond backs a ten-year annuity the pension fund is protected\(^99\) from any change in market conditions. If market yields rise and unrealised losses appear in the bond portfolio, the pension fund can argue that its economic solvency has strengthened, because the market-consistent value of the liabilities—which are of longer duration—has fallen more than that of the assets backing them. If market yields fall, unrealised gains appear and the regulatory funding ratio increases because the liability value remains unchanged. In reality, of course, the situation of the pension fund deteriorates.

Only non-bond assets are at market value in the balance sheet—risky assets are typically managed with a VaR constraint. As indicated, market value adjustments for non-bond assets mean that, unlike bond elements and liabilities, they are valued at close to market value. As non-bond assets trigger underfunding, the market value constraint is generally interpreted as a Value-at-Risk constraint, at a confidence interval specified by the pension fund itself. In other words, there may be incentives to define the optimal portfolio with both a short-term (as opposed to long term) and asset-only (as opposed to ALM) portfolio. The liability, after all, is out of focus (see section 4.2.1 of this document).

\(^99\) The situation is similar for Pensionskassen.
5. Appendices

5.1.4. Switzerland has relatively traditional and flexible regulation

Though not a member of the European Union, Switzerland is in the heart of Europe. After the Netherlands, it has the largest pension fund industry per capita in Europe.

Switzerland has a very large mandatory second pillar with equal contributions from employers and employees

All employees with an income above €16,000 per year are by law covered by occupational pension schemes.

As in the Netherlands, pension funds are foundations, and both employer and employee representatives sit on their boards. Likewise, in the case of plan termination after the bankruptcy of the sponsor, all assets are allocated to plan members.

However, unlike much European regulation (including the Dutch), Swiss regulation provides for no reversion to the sponsor of excess assets. In addition, the law requires that sponsors contribute no less than employees. These two constraints create incentives to limit funding excesses.

As in the UK and Germany, a pension insurance (protection fund) supplements the relatively lax requirements for technical provisions (underfunding is also permitted).

Benefits

The benefits of the second pillar supplement those of the first pillar and cover longevity, disability, and death. The law requires that the first pillar (PAYG) and second pillar combined provide benefits equal to 60% of pre-retirement income, so pension benefits are indexed to the last wage. Rising life expectancy and ageing populations are bound to decrease benefits from the PAYG first pillar, and second-pillar benefits should increase. Accumulated savings are indexed to inflation (previously they were indexed to a combination of the price and wage indices), but this mandatory indexation is not taken into account for valuation purposes. After accumulated savings are converted into annuities, the revaluation of pensions paid is made on a voluntary basis by pension funds. Naturally, pension funds may offer additional contractual benefits, and some index paid pensions to inflation.

The law defines requirements for both contributions and benefits: insured wages, envelope for employer and employee contributions, minimum conversion rate, and minimum guaranteed interest rate. In addition, the plan sponsor cannot contribute less than the employees. However the focus is not on funding requirements.

As Weber and Gerber (2007) notes, one of the most noteworthy characteristics of the Swiss second pillar is its variety. In the box below, one sees that autonomous pension funds bear all risks (longevity, death, and disability) alone or with reinsurance, whereas partly autonomous funds transfer the disability and/or longevity risk to life insurance companies. Collective pension funds, for their part, have entered a collective contract with a life insurance company under which the latter assumes all risks.
There has been an ongoing shift from DB plans to DC plans since the post-2000 stock-market crash. Today, more than three quarters of employees are members of a DC plan. DB plans are still maintained by some large corporations and by most pension funds under public law (those that provide the mandatory part of the second pillar).

Fewer quantitative restrictions
In Switzerland, pension funds are regulated by the Federal Law on Registered Retirement, Survivors’ and Disability Pension Plans (BVG-LPP). (The second pillar, BVG/LPP, is the mandatory occupational pension scheme. It was incorporated in 1972 and became operational in 1985.) Investment guidelines, which relied heavily on quantitative investment limits, were revised in 2000 to impose fewer quantitative limits and introduce the “prudent man rule”, equivalent to the prudent person principle, which emphasises diversification. It is expected that in the future quantitative limits will be simplified further still.

Funding requirements are based on relatively flexible valuation standards
Valuation principles: “flexible” ABO
Assets are taken at market value.
For liabilities, an equity risk premium is allowed for discounting: each pension fund has a specially authorised second pillar expert who sets the discount rate according to the long-term rate of return of a low-risk instrument. In practice, the rate is often the yield of the Swiss Confederation bond with a maturity of ten years plus an equity risk premium, weighted by the share of the investment in risky assets, minus a safety margin. The equity risk premium is measured on a historical basis. Naturally, pension funds without any allocation to equity cannot claim that they expect above-average returns on their investments and report lower liabilities as a consequence. In 2006, the average discount rate at Swiss pension funds was 3.85%.

Accrued benefits exclude mandatory indexation: as mentioned in the description of the second pillar, savings...
must be indexed to inflation. In practice, this mandatory revaluation takes place every two years, following the publication of the consumer price index.

So even though liabilities are indexed to inflation, they are reported as nominal liabilities to the regulator.

On the whole, then, Swiss funding requirements are, from a European perspective, relatively lax.107

A buffer is required for risk-taking
Much like Dutch regulation, but far less formalised at this stage, Swiss regulation (sections 47-2 and 48-E of OPP2 mention a “fluctuation reserve”) requires a buffer for risk-taking. The extent of this buffer is currently left to the discretion of the appointed actuary, but the goal of the regulator is to create a framework that—though more flexible—is gradually brought into line with the requirements made of insurance companies.

Summary of regulatory constraints on the ALM of Swiss pension funds:
Quantitative restrictions still significant
Quantitative limits are often imposed by the regulator to protect plan members from exaggerated risk exposure and subsequent losses, and to provide incentives for risk-free asset allocation.

However, risk-free asset allocation in ALM is exposure not to the cash account but to the replicating portfolio, and such exposure is not always facilitated by quantitative restrictions. Moreover, quantitative restrictions often reduce the ability of the pension fund and of the asset manager to diversify risk exposures. In Switzerland, for example, allocation to foreign assets is limited to 30% of investments, and allocation to foreign equities to 25%.108

As such, these restrictions are at odds with the prudent person principle adopted by Swiss law—the law (BVG/LPP) requires Swiss pension funds to manage their assets in such a manner as to ensure safe investment, an adequate return, appropriate diversification of risk, and sufficient liquidity.

Swiss pension funds must therefore strive for a balance between the flexibility afforded by the prudent person principle and the constraints imposed by quantitative restrictions.

A pension fund that adheres blindly to these restrictions will miss out on many possible diversification benefits. Blind adherence constrains not only the equity allocation, but also the bond allocation. When allocating 25% of the investment portfolio to foreign equities, only 5% of the portfolio can be allocated to foreign bonds. Given that Swiss bond yields are lower than those of the rest of the world109 as well as to once and possibly future Swiss pension inflation, this is a significant restriction.

Pension funds can work around these restrictions by demonstrating the adequateness of their strategies in a special yearly report addressing each instance of deviation from the legal limits.110 A pension fund that has sound (ex-ante) investment principles and justifies (ex-post) its strategy may deviate from quantitative restrictions.
It is largely pension funds that are both large and well funded that take advantage of this possibility.

By contrast, pension funds that either lack research and reporting capabilities or have a lower funding ratio need to apply quantitative limits. After all, the risk capability of a pension fund is determined by its current coverage ratio (ratio of assets to pension liabilities), so a pension fund with a low funding ratio cannot justify the additional risk represented by deviating from the legal limits.

In addition, the law stipulates that the board of the pension fund have a full grasp of the strategies implemented. This stipulation raises another obstacle to investing in complex instruments such as structured products or derivatives, as the board needs to show that it understands the risk-return characteristics of such investments—with traditional investments such as equities and bonds, on the contrary, there is no such stipulation, even though their real risk-return characteristics are arguably as difficult to model and understand as those of some structured products or hedge funds. Strategies that are easy to understand are not necessarily adequate.

The combination of an equity risk premium and a minimum funding ratio creates the specific risk of trapping a pension fund.

As detailed in section 4.2.4, when firms naively use an equity risk premium to discount liabilities, there is a risk of being trapped after market downturns. After all, when the value of assets falls, so do estimates of the risk premium. The fall in equity prices subsequently increases the reported value of the liability and therefore further lowers the funding ratio, in a way that is frequently not monitored by risk management, which focuses more closely on asset risk than on asset-liability risk.

Management of inflation risk should be handled with care.

As we have seen, the benefits paid out to participants are strictly regulated. By setting the guaranteed interest rate as well as the conversion rate, the regulator actually simplifies liability analysis. It is simplified all the more by Switzerland’s stable regulatory environment;\(^{111}\) “legislative risk” is not as great as in other countries. However, by failing to recognise inflation in the regulatory liability value, and in the funding ratio, the regulator may be failing to provide incentives to manage inflation risk adequately (see section 4.3.1).

Overall, situations that result in shedding most equity exposure and in suppressing all indexation to the economy and to prices on the asset side make it impossible both to replicate liabilities as they are and to offer the indexation promised. It is probably for this reason that, in regulations that allow discounting at an equity risk premium, funding requirements are generally relaxed after falls in equity prices.

\(^{111}\) Swiss pension legislation undergoes a thorough review every ten years and fine-tuning in between. The major change in the benefits is that indexation changed from an average of wage and inflation to inflation only, and that the conversion rate also changed.
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### 5.2. OECD Pension Glossary

By courtesy of the OECD. Excerpt.

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<th>Term</th>
<th>Definition</th>
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<th>Identical terms</th>
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<tr>
<td>3 Accrued benefits</td>
<td>The amount of accumulated pension benefits of a pension plan member on the basis of years of service.</td>
<td></td>
<td>Accrued rights</td>
</tr>
<tr>
<td>5 Accumulated assets (contributions)</td>
<td>The total value of assets accumulated in a pension fund.</td>
<td></td>
<td>Accumulated contributions</td>
</tr>
<tr>
<td>6 Accumulated Benefit Obligation (ABO)</td>
<td>The actuarial present value of benefits, vested and non-vested, attributed to the pension formula to employee service rendered to a particular date, based on current salaries.</td>
<td>Projected Benefit Obligation (PBO)</td>
<td></td>
</tr>
<tr>
<td>8 Active member</td>
<td>A pension plan member who is making contributions (and/or on behalf of whom contributions are being made) and is accumulating assets.</td>
<td></td>
<td>Pension plan member</td>
</tr>
<tr>
<td>9 Actuarial assumptions</td>
<td>The various estimates (including assumptions related to changes in longevity, wage, inflation, returns on assets, etc.) that the actuary makes in formulating the actuarial valuation.</td>
<td></td>
<td>Actuary Actuarial valuation</td>
</tr>
<tr>
<td>10 Actuarial deficiency (deficit)</td>
<td>In a situation when the actuarial value of a pension fund’s assets is less than the actuarial liability, the measure of this value.</td>
<td>Actuarial surplus Actuarial valuation</td>
<td>Deficiency deficit</td>
</tr>
<tr>
<td>12 Actuarial liability</td>
<td>The amount calculated based on actuarial assumptions that represent the present value of the pension benefits accrued in a pension plan.</td>
<td></td>
<td>Actuarial valuation</td>
</tr>
<tr>
<td>14 Actuarial report</td>
<td>The report prepared by the actuary following the actuarial valuation that describes the financial position of the pension fund.</td>
<td></td>
<td>Actuarial valuation</td>
</tr>
<tr>
<td>15 Actuarial surplus</td>
<td>In a situation when the actuarial liability is less than the actuarial value of a pension fund’s assets, the measure of this value.</td>
<td>Actuarial deficiency Overfunding Actuarial valuation Surplus</td>
<td></td>
</tr>
<tr>
<td>16 Actuarial valuation</td>
<td>A valuation carried out by an actuary on a regular basis, in particular to test future funding or current solvency of the value of the pension fund’s assets with its liabilities.</td>
<td>Actuarial deficiency Actuarial surplus</td>
<td>Valuation</td>
</tr>
<tr>
<td>18 Administration</td>
<td>The operation and oversight of a pension fund.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Annual report</td>
<td>A report prepared each year by the pension fund, which informs of its operation, and other information whereby the trustees of pension funds inform all interested parties.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 Annuitant</td>
<td>The person who is covered by an annuity and who will normally receive the benefits of the annuity.</td>
<td></td>
<td>Annuity</td>
</tr>
<tr>
<td>22 Annuity</td>
<td>A form of financial contract mostly sold by life insurance companies that guarantees a fixed or variable payment of income benefit (monthly, quarterly, half-yearly, or yearly) for the life of a person(s) (the annuitant) or for a specified period of time. It is different than a life insurance contract which provides income to the beneficiary after the death of the insured. An annuity may be bought through instalments or as a single lump sum. Benefits may start immediately or at a pre-defined time in the future or at a specific age.</td>
<td>Annuity rate</td>
<td>Pension annuity</td>
</tr>
<tr>
<td>23 Annuity rate</td>
<td>The present value of a series of payments of unit value per period payable to an individual that is calculated based on factors such as the mortality of the annuitant and the possible investment returns.</td>
<td>Unisex annuity rate Unistatus annuity rate</td>
<td></td>
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<tr>
<td>29</td>
<td>Average earnings scheme</td>
<td>A scheme where the pension benefits earned for a year depend on how much the member's earnings were for the given year.</td>
<td>Career average scheme</td>
</tr>
<tr>
<td>31</td>
<td>Basic state pension</td>
<td>A non-earning related pension paid by the State to individuals with a minimum number of service years.</td>
<td>Basic pension</td>
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<td>33</td>
<td>Benefit</td>
<td>Payment made to a pension fund member (or dependants) after retirement.</td>
<td>Pension benefit retirement benefit</td>
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<td>34</td>
<td>Benefit statement</td>
<td>A statement of the pension benefits an individual has earned (in a defined benefit plan) or a prediction of what the final pension might be (in a defined contribution plan).</td>
<td>Annual pension estimate</td>
</tr>
<tr>
<td>35</td>
<td>Book reserved pension plans</td>
<td>Sums entered in the balance sheet of the plan sponsor as reserves or provisions for occupational pension plan benefits. Some assets may be held in separate accounts for the purpose of financing benefits, but are not legally or contractually pension plan assets. Most OECD countries do not allow this method of financing. Those that do usually require these plans to be insured against bankruptcy of the plan sponsor through insolvency guaranty arrangement.</td>
<td>Funded pension plans unfunded pension plans</td>
</tr>
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<td>36</td>
<td>Career average scheme</td>
<td>-&gt;</td>
<td>Average earnings scheme</td>
</tr>
<tr>
<td>37</td>
<td>Closed pension funds</td>
<td>Funds that support only pension plans that are limited to certain employees. (e.g. those of an employer or group of employers).</td>
<td>Open pension fund</td>
</tr>
<tr>
<td>39</td>
<td>Contribution</td>
<td>A payment made to a pension plan by a plan sponsor or a plan member.</td>
<td>Pension contribution</td>
</tr>
<tr>
<td>41</td>
<td>Contribution holiday</td>
<td>A period when the contributions to a pension scheme are put on hold, the most common reason for this being a situation of overfunding.</td>
<td>Overfunding</td>
</tr>
<tr>
<td>42</td>
<td>Contribution rate</td>
<td>The amount (typically expressed as a percentage of the contribution base) that is needed to be paid into the pension fund.</td>
<td>Contribution base funding rate</td>
</tr>
<tr>
<td>44</td>
<td>Corporate trustee</td>
<td>A company that acts as a trustee.</td>
<td>Trustee</td>
</tr>
<tr>
<td>45</td>
<td>Custodian</td>
<td>The entity responsible, as a minimum, for holding the pension fund assets and for ensuring their safekeeping.</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>DB system</td>
<td>-&gt;</td>
<td>Defined benefit plans</td>
</tr>
<tr>
<td>47</td>
<td>DC system</td>
<td>-&gt;</td>
<td>Defined contribution plans</td>
</tr>
<tr>
<td>48</td>
<td>Deferred pension</td>
<td>A pension arrangement in which a portion of an employee's income is paid out at a date after which that income is actually earned.</td>
<td>Deferred pensioner deferred retirement</td>
</tr>
<tr>
<td>51</td>
<td>Deferred member</td>
<td>A pension plan member that no longer contributes to or accrues benefits from the plan but has not yet begun to receive retirement benefits from that plan.</td>
<td>Inactive member</td>
</tr>
<tr>
<td>53</td>
<td>Defined benefit (DB) occupational pension plans</td>
<td>Occupational plans other than defined contributions plan. DB plans generally can be classified into one of three main types, &quot;traditional&quot;, &quot;mixed&quot; and &quot;hybrid&quot; plans.</td>
<td>&quot;Traditional&quot; DB plans &quot;Hybrid&quot; DB plans &quot;Mixed&quot; DB plans defined contribution (DC) occupational pension plans</td>
</tr>
<tr>
<td>54</td>
<td>&quot;Traditional&quot; DB plan</td>
<td>A DB plan where benefits are linked through a formula to the members' wages or salaries, length of employment, or other factors.</td>
<td>Defined benefit (DB) occupational pension plans &quot;Hybrid&quot; DB plans &quot;Mixed&quot; DB plans Defined contribution (DC) occupational pension plans</td>
</tr>
<tr>
<td>55</td>
<td>&quot;Hybrid&quot; DB plan</td>
<td>A DB plan where benefits depend on a rate of return credited to contributions, where this rate of return is either specified in the plan rules, independently of the actual return on any supporting assets (e.g., fixed, indexed to a market benchmark, tied to salary or profit growth, etc.), or is calculated with reference to the actual return of any supporting assets and a minimum return guarantee specified in the plan rules.</td>
<td>Defined benefit (DB) occupational pension plans &quot;Traditional&quot; DB plans &quot;Mixed&quot; DB plans Defined contribution (DC) occupational pension plans</td>
</tr>
<tr>
<td>56</td>
<td>&quot;Mixed&quot; DB plans</td>
<td>DB plans that have two separate DB and DC components but which are treated as part of the same plan.</td>
<td>Defined benefit (DB) occupational pension plans &quot;Traditional&quot; DB plans &quot;Hybrid&quot; DB plans Defined contribution (DC) occupational pension plans</td>
</tr>
<tr>
<td>57</td>
<td>Defined contribution (DC) occupational pension plans</td>
<td>Occupational pension plans under which the plan sponsor pays fixed contributions and has no legal or constructive obligation to pay further contributions to an ongoing plan in the event of unfavourable plan experience.</td>
<td>Defined benefit (DB) occupational pension plans &quot;Traditional&quot; DB plans &quot;Hybrid&quot; DB plans &quot;Mixed&quot; DB plans Defined contribution (DC) occupational pension plans</td>
</tr>
<tr>
<td>59</td>
<td>Dependency ratio</td>
<td>Typically defined as the ratio of those of non-active age to those of active age in a given population.</td>
<td>System dependency ratio</td>
</tr>
<tr>
<td>60</td>
<td>Disclosure regulations</td>
<td>The rules the pension plan must follow when providing information on the plan operation to its members and the supervisory authority.</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>Employer's pension plan -&gt;</td>
<td>-&gt;</td>
<td>Occupational pension plans Company pension plans</td>
</tr>
<tr>
<td>65</td>
<td>Fair value</td>
<td>The price at which an asset would change hands between a willing buyer and a willing seller, neither being under any compulsion to buy or to sell and both having reasonable knowledge of relevant facts.</td>
<td>Market value</td>
</tr>
<tr>
<td>66</td>
<td>Final average earnings</td>
<td>The fund member's earnings that are used to calculate the pension benefit in a defined benefit plan; it is typically the earnings of the last few years prior to retirement.</td>
<td>Defined benefit plan Final average earnings Flat rate scheme Earnings related pensions</td>
</tr>
<tr>
<td>68</td>
<td>Final salary (earnings) scheme</td>
<td>A type of defined benefit plan, whereby the pension benefit is typically based on the last few years' earnings before retirement.</td>
<td>Final earnings scheme</td>
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<table>
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<th>69</th>
<th>Flat rate scheme</th>
<th>A type of defined benefit scheme, whereby the pension benefit is only based on the length of membership in the scheme and is not affected by earnings.</th>
<th>Defined benefit plan Final salary scheme</th>
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<td>70</td>
<td>Fund member</td>
<td>An individual who is either an active (working or contributing, and hence actively accumulating assets) or passive (retired, and hence receiving benefits), or deferred (holding deferred benefits) participant in a pension plan.</td>
<td>Active member</td>
</tr>
<tr>
<td>71</td>
<td>Funded pension plans</td>
<td>Occupational or personal pension plans that accumulate dedicated assets to cover the plan’s liabilities.</td>
<td>Pay-As-You-Go (PAYG) plan Unfunded pension plans Book reserved pension plans</td>
</tr>
<tr>
<td>72</td>
<td>Funding</td>
<td>The act of accumulating assets in order to finance the pension plan.</td>
<td>Actuarial valuation</td>
</tr>
<tr>
<td>74</td>
<td>Funding plan</td>
<td>The timing of payments of contributions with the aim of meeting the cost of a given set of benefits under a defined benefit scheme. Possible objectives of a funding plan might be that, if the actuarial assumptions are borne out: a) a specified funding level should be reached by a given date; b) the level of contributions should remain constant, or should after a planned period be the standard contribution rate required by the valuation method used in the actuarial valuation.</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>Funding ratio</td>
<td>The relative value of a scheme’s assets and liabilities, expressed as a fraction.</td>
<td>Funding level</td>
</tr>
<tr>
<td>77</td>
<td>Funding rules</td>
<td>Regulation that requires the maintenance of a certain level of assets in a pension fund in relation to pension plan liabilities.</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>Governing body (of the pension fund)</td>
<td>Governing body (of the pension fund): this is the person(s) ultimately responsible for managing the pension fund with the overriding objective of providing a secure source of retirement income. In cases where operational and oversight responsibilities are split between different committees within an entity, the governing body is the executive board of the entity. Where the pension fund is not a legal entity, but managed directly by a financial institution, that institution’s board of directors is also the governing body of the pension fund.</td>
<td>Administrator</td>
</tr>
<tr>
<td>79</td>
<td>Gross rate of return</td>
<td>The rate of return of an asset or portfolio over a specified time period, prior to discounting any fees or commissions.                                                      Rate of return Net rate of return</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>Group pension funds</td>
<td>Multi-employer pension funds that pool the assets of pension plans established for related employers.</td>
<td>Collective pension funds Related member funds Individual pension funds Industry pension funds Multi-employer pension funds Single employer pension funds</td>
</tr>
<tr>
<td>82</td>
<td>Guaranteed annuity</td>
<td>An annuity that is paid until the death of the annuitant. If this occurs prior to a certain date, the annuity is then paid to their dependants until that date.</td>
<td>Annuity</td>
</tr>
<tr>
<td>83</td>
<td>Inactive member</td>
<td>-&gt;</td>
<td>Deferred member</td>
</tr>
</tbody>
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<tr>
<th>84</th>
<th>Income replacement rate</th>
<th>Replacement rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>Indexation</td>
<td>The method with which pension benefits are adjusted to take into account changes in the cost of living (e.g. prices and/or earnings).</td>
</tr>
<tr>
<td>86</td>
<td>Individual pension funds</td>
<td>A pension fund that comprises the assets of a single member and his/her beneficiaries, usually in the form of an individual account.</td>
</tr>
<tr>
<td>87</td>
<td>Industry pension funds</td>
<td>Funds that pool the assets of pension plans established for unrelated employers who are involved in the same trade or businesses.</td>
</tr>
<tr>
<td>90</td>
<td>Liabilities (value of)</td>
<td>Value of liabilities.</td>
</tr>
<tr>
<td>91</td>
<td>Mandatory contribution</td>
<td>The level of contribution the member (or an entity on behalf of the member) is required to pay according to scheme rules.</td>
</tr>
<tr>
<td>92</td>
<td>Mandatory occupational plans</td>
<td>Participation in these plans is mandatory for employers. Employers are obliged by law to participate in a pension plan. Employers must set up (and make contributions to) occupational pension plans which employees will normally be required to join. Where employers are obliged to offer an occupational pension plan, but the employees’ membership is on a voluntary basis, these plans are also considered mandatory.</td>
</tr>
<tr>
<td>93</td>
<td>Mandatory personal pension plans</td>
<td>These are personal plans that individuals must join or which are eligible to receive mandatory pension contributions. Individuals may be required to make pension contributions to a pension plan of their choice normally within a certain range of choices or to a specific pension plan.</td>
</tr>
<tr>
<td>94</td>
<td>Market value</td>
<td>The price at which an asset would change hands if it sold on the open market.</td>
</tr>
<tr>
<td>97</td>
<td>Minimum pension (benefit)</td>
<td>The minimum level of pension benefits the plan pays out in all circumstances.</td>
</tr>
<tr>
<td>98</td>
<td>Mixed indexation</td>
<td>The method with which pension benefits are adjusted taking into account changes in both wages and prices.</td>
</tr>
<tr>
<td>99</td>
<td>Money purchase plan</td>
<td>A pension plan providing benefits on a money purchase basis (i.e. the determination of an individual member’s benefits by reference to contributions paid into the scheme in respect of that member, usually increased by an amount based on the investment return on those contributions).</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Topic</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Multi-employer pension funds</td>
<td>Funds that pool the assets of pension plans established by various plan sponsors. There are three types of multi-employer pension funds: a) for related employers i.e. companies that are financially connected or owned by a single holding group (group pension funds); b) for unrelated employers who are involved in the same trade or business (industry pension funds); c) for unrelated employers that may be in different trades or businesses (collective pension funds).</td>
</tr>
<tr>
<td>Group pension funds</td>
<td>Individual pension funds</td>
</tr>
<tr>
<td>Industry pension funds</td>
<td>Multi-employer pension funds</td>
</tr>
<tr>
<td>Related pension funds</td>
<td>Single employer pension funds</td>
</tr>
<tr>
<td>Net rate of return</td>
<td>The rate of return of an asset or portfolio over a specified time period, after discounting any fees or commissions.</td>
</tr>
<tr>
<td>Rate of return</td>
<td>Gross rate of return</td>
</tr>
<tr>
<td>Normal retirement age</td>
<td>Age from which the individual is eligible for pension benefits.</td>
</tr>
<tr>
<td>Normal pension age</td>
<td>Retirement age</td>
</tr>
<tr>
<td>Occupational pension plans</td>
<td>Access to such plans is linked to an employment or professional relationship between the plan member and the entity that establishes the plan (the plan sponsor). Occupational plans may be established by employers or groups thereof (e.g. industry associations) and labour or professional associations, jointly or separately. The plan may be administered directly by the plan sponsor or by an independent entity (a pension fund or a financial institution acting as pension provider). In the latter case, the plan sponsor may still have oversight responsibilities over the operation of the plan.</td>
</tr>
<tr>
<td>Mandatory occupational pension plans</td>
<td>Voluntary occupational pension plans</td>
</tr>
<tr>
<td>Company pension plans</td>
<td>Employer's pension plans</td>
</tr>
<tr>
<td>Open pension funds</td>
<td>Funds that support at least one plan with no restriction on membership.</td>
</tr>
<tr>
<td>Closed pension funds</td>
<td></td>
</tr>
<tr>
<td>Overfunding</td>
<td>The situation when the value of a plan's assets is more than its liabilities, thereby having an actuarial surplus.</td>
</tr>
<tr>
<td>Funding level</td>
<td>Actuarial surplus Underfunding</td>
</tr>
<tr>
<td>Oversight committee</td>
<td>-&gt;</td>
</tr>
<tr>
<td>Supervisory body</td>
<td></td>
</tr>
<tr>
<td>Participant</td>
<td>-&gt;</td>
</tr>
<tr>
<td>Fund member</td>
<td></td>
</tr>
<tr>
<td>Pay-As-You-Go (PAYG) plan</td>
<td>-&gt;</td>
</tr>
<tr>
<td>Funded pension plans</td>
<td>Unfunded pension plans</td>
</tr>
<tr>
<td>Pension assets</td>
<td>All forms of investment with a value associated to a pension plan.</td>
</tr>
<tr>
<td>Liabilities</td>
<td></td>
</tr>
<tr>
<td>Pension funds</td>
<td>The pool of assets forming an independent legal entity that are bought with the contributions to a pension plan for the exclusive purpose of financing pension plan benefits. The plan/fund members have a legal or beneficial right or some other contractual claim against the assets of the pension fund. Pension funds take the form of either a special purpose entity with legal personality (such as a trust, foundation, or corporate entity) or a legally separated fund without legal personality managed by a dedicated provider (pension fund management company) or other financial institution on behalf of the plan/fund members.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Pension fund administrator</td>
<td>The individual(s) ultimately responsible for the operation and oversight of the pension fund.</td>
</tr>
<tr>
<td>Governing body</td>
<td></td>
</tr>
<tr>
<td>Pension fund governance</td>
<td>The operation and oversight of a pension fund. The governing body is responsible for administration, but may employ other specialists, such as actuaries, custodians, consultants, asset managers and advisers to carry out specific operational tasks or to advise the plan administration or governing body.</td>
</tr>
</tbody>
</table>
### 5. Appendices

<table>
<thead>
<tr>
<th>Term</th>
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<tbody>
<tr>
<td>120</td>
<td>Pension fund managing company</td>
</tr>
<tr>
<td>121</td>
<td>Pension fund member</td>
</tr>
<tr>
<td>122</td>
<td>Pension insurance contracts</td>
</tr>
<tr>
<td>123</td>
<td>Pension plan (scheme)</td>
</tr>
<tr>
<td>124</td>
<td>Pension plan administrator</td>
</tr>
<tr>
<td>129</td>
<td>Pension plan sponsor</td>
</tr>
<tr>
<td>130</td>
<td>Pension regulator</td>
</tr>
<tr>
<td>132</td>
<td>Pension supervisor</td>
</tr>
<tr>
<td>133</td>
<td>Pensionable age</td>
</tr>
<tr>
<td>134</td>
<td>Pensionable service</td>
</tr>
<tr>
<td>136</td>
<td>Personal pension plans (individual pension plans)</td>
</tr>
<tr>
<td>138</td>
<td>Plan member</td>
</tr>
<tr>
<td>139</td>
<td>Plan sponsor</td>
</tr>
<tr>
<td>141</td>
<td>Price indexation</td>
</tr>
<tr>
<td>142</td>
<td>Private pension funds</td>
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</tr>
<tr>
<td>142</td>
<td>Private pension funds</td>
</tr>
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| 143 | Private pension plans | A pension plan administered by an institution other than general government. Private pension plans may be administered directly by a private sector employer acting as the plan sponsor, a private pension fund or a private sector provider. Private pension plans may complement or substitute for public pension plans. | Public pension plans |
| 144 | Projected Benefit Obligation (PBO) | The actuarial present value of vested and non-vested benefits attributed to the plan through the pension benefit formula for service rendered to that date based on employees’ future salary levels. | Accumulated Benefit Obligation (ABO) |
| 146 | Public pension funds | Pension funds that are regulated under public sector law. | Private pension funds |
| 147 | Social security and similar statutory programmes administered by the general government (that is central, state, and local governments, as well as other public sector bodies such as social security institutions). Public pension plans have been traditionally PAYG financed, but some OECD countries have partial funding of public pension liabilities or have replaced these plans by private pension plans. | Private pension plan |
| 149 | Rate of return | The income earned by holding an asset over a specified period. | Gross rate of return Net rate of return |
| 152 | Replacement rate | The ratio of an individual’s (or a given population’s) (average) pension in a given time period and the (average) income in a given time period. | Income replacement rate |
| 156 | Separate accounts | A pension fund that is legally segregated from both the plan sponsor and a financial institution that acts as the manager of the fund on behalf of the plan member. | Pension fund Plan sponsor Plan member |
| 157 | Service period | The length of time an individual has earned rights to a pension benefits. | Pensionable service |
| 158 | Single employer pension funds (corporate pension fund) | Funds that pool the assets of pension plans established by a single sponsor. | Collective pension funds Related member funds Individual pension funds Industry pension funds Multi-employer pension funds Group pension funds |
| 161 | Supervisory board | The individual(s) responsible for monitoring the governing body of a pension entity. | Oversight committee |
| 166 | Termination | Winding up |
| 167 | TPA (Third Party Administrator) | An entity other than a plan sponsor, that is responsible for administering an occupational pension plan. | |
| 168 | Trust | A legal scheme, whereby named people (termed trustees) hold property on behalf of other people (termed beneficiaries). | Trust |
| 169 | Trustee | A person or a company appointed to carry out the tasks of the trust. | Corporate trustee Trust |
| 170 | Underfunding | The situation when the value of a plan’s assets is less than its liabilities, thereby having an actuarial deficiency. | Funding level Actuarial deficiency Overfunding |
## 5. Appendices

<table>
<thead>
<tr>
<th>Code</th>
<th>Term</th>
<th>Description</th>
<th>Code</th>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>171</td>
<td>Unfunded pension plans</td>
<td>Plans that are financed directly from contributions from the plan sponsor or provider and/or the plan participant. Unfunded pension plans are said to be paid on a current disbursement method (also known as the pay as you go, PAYG, method). Unfunded plans may still have associated reserves to cover immediate expenses or smooth contributions within given time periods. Most OECD countries do not allow unfunded private pension plans.</td>
<td>179</td>
<td>Vested benefits (rights)</td>
<td>Deferred pensions for deferred pensioners, benefits accrued to active members and benefits of passive members.</td>
</tr>
<tr>
<td>181</td>
<td>Voluntary occupational pension plans</td>
<td>The establishment of these plans is voluntary for employers (including those in which there is automatic enrolment as part of an employment contract or where the law requires employees to join plans set up on a voluntary basis by their employers). In some countries, employers can on a voluntary basis establish occupational plans that provide benefits that replace at least partly those of the social security system. These plans are classified as voluntary, even though employers must continue sponsoring these plans in order to be exempted (at least partly) from social security contributions.</td>
<td>183</td>
<td>Wage indexation</td>
<td>The method with which pension benefits are adjusted taking into account changes in wages.</td>
</tr>
<tr>
<td>184</td>
<td>Waiting period</td>
<td>The length of time an individual must be employed by a particular employer before joining the employer's pension scheme.</td>
<td>185</td>
<td>Winding-up</td>
<td>The termination of a pension scheme by either providing (deferred) annuities for all members or by moving all its assets and liabilities into another scheme.</td>
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</tbody>
</table>
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References


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About the EDHEC Risk and Asset Management Research Centre

EDHEC is one of the top five business schools in France. Its reputation is built on the high quality of its faculty (110 professors and researchers from France and abroad) and the privileged relationship with professionals that the school has been developing since its establishment in 1906. EDHEC Business School has decided to draw on its extensive knowledge of the professional environment and has therefore focused its research on themes that satisfy the needs of professionals.

EDHEC is one of the few business schools in Europe to have received the triple international accreditation: AACSB (US-Global), Equis (Europe-Global) and Association of MBAs (UK-Global).

EDHEC pursues an active research policy in the field of finance. The EDHEC Risk and Asset Management Research Centre carries out numerous research programmes in the areas of asset allocation and risk management in both the traditional and alternative investment universes.

The choice of asset allocation
The EDHEC Risk and Asset Management Research Centre structures all of its research work around asset allocation. This issue corresponds to a genuine expectation from the market. On the one hand, the prevailing stock market situation in recent years has shown the limitations of active management based solely on stock picking as a source of performance.

On the other, the appearance of new asset classes (hedge funds, private equity), with risk profiles that are very different from those of the traditional investment universe, constitutes a new opportunity in both conceptual and operational terms. This strategic choice is applied to all of the Centre’s research programmes, whether they involve proposing new methods of strategic allocation, which integrate the alternative class; measuring the performance of funds while taking the tactical allocation dimension of the alpha into account; taking extreme risks into account in the allocation; or studying the usefulness of derivatives in constructing the portfolio.

An applied research approach
In an attempt to ensure that the research it carries out is truly applicable, EDHEC has implemented a dual validation system for the work of the EDHEC Risk and Asset Management Research Centre. All research work must be part of a research programme, the relevance and goals of which have been validated from both an academic and a business viewpoint by the Centre’s advisory board. This board is made up of both internationally recognised researchers and the Centre’s business partners. The management of the research programmes respects a rigorous validation process, which guarantees the scientific quality and the operational usefulness of the programmes.

To date, the Centre has implemented six research programmes:

**Asset Allocation and Alternative Diversification**
*Sponsored by SG Asset Management and Newedge*

The research carried out focuses on the benefits, risks and integration methods of the alternative class in asset allocation. From that perspective, EDHEC is making a significant contribution to the research conducted in the area of multi-style/multi-class portfolio construction.

**Performance and Style Analysis**
*Part of a business partnership with EuroPerformance*

The scientific goal of the research is to adapt the portfolio performance and style analysis models and methods to tactical allocation. The results of the research carried out by EDHEC thereby allow portfolio alpha to be measured not only for stock picking but also for style timing.

**Indices and Benchmarking**
*Sponsored by Af2i, Barclays Global Investors, BNP Paribas Investment Partners, NYSE Euronext, Lyxor Asset Management, and UBS Global Asset Management*

This research programme has given rise to extensive research on the subject of indices and benchmarks in both the hedge fund universe and more traditional investment
About the EDHEC Risk and Asset Management Research Centre

classes. Its main focus is on analysing the quality of indices and the criteria for choosing indices for institutional investors. EDHEC also proposes an original proprietary style index construction methodology for both the traditional and alternative universes. These indices are intended to be a response to the critiques relating to the lack of representativeness of the style indices that are available on the market. In 2003, EDHEC launched the first composite hedge fund strategy indices.

Asset Allocation and Derivatives
Sponsored by Eurex, SGCI8 and the French Banking Federation
This research programme focuses on the usefulness of employing derivative instruments in the area of portfolio construction, whether it involves implementing active portfolio allocation or replicating indices. "Passive" replication of "active" hedge fund indices through portfolios of derivative instruments is a key area in the research carried out by EDHEC. This programme includes the "Structured Products and Derivatives Instruments" research chair sponsored by the French Banking Federation.

Best Execution and Operational Performance
Sponsored by CACEIS, NYSE Euronext, and SunGard
This research programme deals with two topics: best execution and, more generally, the issue of operational risk. The goal of the research programme is to develop a complete framework for measuring transaction costs: EBEX ("Estimated Best Execution") but also to develop the existing framework for specific situations (constrained orders, listed derivatives, etc.). Research also focuses on risk-adjusted performance measurement of execution strategies, analysis of market impact and opportunity costs on listed derivatives order books, the impact of explicit and implicit transaction costs on portfolio performances, and the impact of market fragmentation resulting from MiFID on the quality of execution in European listed securities markets. This programme includes the "MiFID and Best Execution" research chair, sponsored by CACEIS, NYSE Euronext, and SunGard.

ALM and Asset Management
Sponsored by BNP Paribas Investment Partners, AXA Investment Managers and ORTEC Finance
This research programme concentrates on the application of recent research in the area of asset-liability management for pension plans and insurance companies. The research centre is working on the idea that improving asset management techniques and particularly strategic allocation techniques has a positive impact on the performance of asset-liability management programmes. The programme includes research on the benefits of alternative investments, such as hedge funds, in long-term portfolio management. Particular attention is given to the institutional context of ALM and notably the integration of the impact of the IFRS standards and the Solvency II directive project. It also aims to develop an ALM approach addressing the particular needs, constraints, and objectives of the private banking clientele. This programme includes the "Regulation and Institutional Investment" research chair, sponsored by AXA Investment Managers, the "Asset-Liability Management and Institutional Investment Management" research chair, sponsored by BNP Paribas Investment Partners and the "Private Asset-Liability Management" research chair, in partnership with ORTEC Finance.
About the EDHEC Risk and Asset Management Research Centre

Ten research chairs have been endowed:

**Regulation and Institutional Investment**
In partnership with AXA Investment Managers
The chair investigates the interaction between regulation and institutional investment management on a European scale and highlights the challenges of regulatory developments for institutional investment managers.

**Asset-Liability Management and Institutional Investment Management**
In partnership with BNP Paribas Investment Partners
The chair examines advanced asset-liability management topics such as dynamic allocation strategies, rational pricing of liability schemes, and formulation of an ALM model integrating the financial circumstances of pension plan sponsors.

**MiFID and Best Execution**
In partnership with NYSE Euronext, SunGard, and CACEIS Investor Services
The chair looks at two crucial issues linked to the Markets in Financial Instruments Directive: building a complete framework for transaction cost analysis and analysing the consequences of market fragmentation.

**Structured Products and Derivative Instruments**
In partnership with the French Banking Federation (FBF)
The chair investigates the optimal design of structured products in an ALM context and studies structured products and derivatives on relatively illiquid underlying instruments.

**Financial Engineering and Global Alternative Portfolios for Institutional Investors**
In partnership with Morgan Stanley Investment Management
The chair adapts risk budgeting and risk management concepts and techniques to the specificities of alternative investments, both in the context of asset management and asset-liability management.

**Private Asset-Liability Management**
In partnership with ORTEC Finance
The chair will focus on the benefits of the asset-liability management approach to private wealth management, with particular attention being given to the life cycle asset allocation topic.

**Dynamic Allocation Models and New Forms of Target Funds**
In partnership with Groupe UFG
The chair consists of academic research devoted to the analysis and improvement of dynamic allocation models and new forms of target funds.

**Advanced Modelling Techniques for Hedge Fund Returns**
In partnership with Newedge
The chair involves a three-year project whereby academic research dedicated to hedge funds and to the analysis and modelling of their returns will be conducted.

**Asset-Liability Management Techniques for Sovereign Wealth Fund (SWF) Management**
In partnership with Deutsche Bank
The chair introduces a formal dynamic asset allocation model that will incorporate the most salient factors in sovereign wealth fund management and propose
an empirical analysis of the risk factors impacting the inflows and outflows of cash for various sovereign funds.

Core-Satellite and ETF Investment

*In partnership with CASAM*

The research chair consists of conducting academic research dedicated to exchange traded funds (ETFs) and their use within the framework of a core-satellite investment approach.

The EDHEC PhD in Finance

The PhD in Finance at EDHEC Business School is designed for professionals who aspire to higher intellectual levels and aim to redefine the investment banking and asset management industries.

It is offered in two tracks: a residential track for high-potential graduate students who will hold part-time positions at EDHEC Business School, and an executive track for practitioners who will keep their full-time jobs.

Drawing its faculty from the world’s best universities and enjoying the support of the research centre with the most impact on the European financial industry, the EDHEC PhD in Finance creates an extraordinary platform for professional development and industry innovation.

Research for Business

To optimise exchanges between the academic and business worlds, the EDHEC Risk and Asset Management Research Centre maintains a website devoted to asset management research for the industry: www.edhec-risk.com, circulates a monthly newsletter to over 250,000 practitioners, conducts regular industry surveys and consultations, and organises annual conferences for the benefit of institutional investors and asset managers. The Centre’s activities have also given rise to the business offshoots and EDHEC Asset Management Education.

EDHEC Asset Management Education helps investment professionals to upgrade their skills with advanced risk and asset management training across traditional and alternative classes.
EDHEC Position Papers
and Publications from the last four years

EDHEC Risk and Asset Management Research Centre
2009 Position Papers

2008 Position Papers
• Amenc, N., and S. Sender. Assessing the European banking sector bailout plans (December).
• Amenc, N., and S. Sender. Les mesures de recapitalisation et de soutien à la liquidité du secteur bancaire européen (December).
• Amenc, N., F. Ducoulombier, and P. Foulquier. Reactions to an EDHEC study on the fair value controversy (December). With the EDHEC Financial Analysis and Accounting Research Centre.
• Amenc, N., and V. Le Sourd. Les performances de l’investissement socialement responsable en France (December).
• Amenc, N., and V. Le Sourd. Socially responsible investment performance in France (December).
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* Global Investor Magazine GI100 as at 30/06/2008