FINANCE AND INVESTMENT CONFERENCE
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RISK AND CAPITAL ASSESSMENT AND SUPERVISION IN FINANCIAL FIRMS

INTERIM WORKING PARTY REPORT

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INTRODUCTION

"Understanding how financial firms beyond banks and securities firms operate has become imperative, because the largest insurance companies, mutual funds, hedge funds, and finance companies increasingly rival banks and securities firms not only in their asset size but also in their ability to reshape financial activity. The near failure of Long-Term Capital Management in 1998 illustrated the extent to which financial stability could be threatened by these newly important financial market participants.

In the area of financial supervision*, we plan to advance the continuous supervision model the Federal Reserve System has adopted to critically assess the performance of supervised institutions. We intend to make that assessment while providing significant value to the institutions we supervise, limiting the burden of regulation and supervision, and dealing firmly with the problems that are uncovered. As a special area of emphasis, we plan to continue our leadership role in evaluating how risks are measured, managed, and controlled, and how banking, securities, and insurance risks can be addressed in a common framework."*

Bill McDonough, architect of the new Basel Accord, in the Annual Report of the Federal Reserve Bank of New York, 2002

The original objective of this working party was to prepare a paper to be delivered initially at the Finance and Investment Conference of the actuarial profession in June 2003 covering the assessment of the adequacy of capital resources at the disposal of financial firms.

"The working party is aware that much research activity is going on in this field on the part of the actuarial profession, academics, supervisors and other bodies across the world. We envisage that our particular focus will be:

- To collate and critique as much as practicable of the research being carried out by others;
- To describe relevant issues or background which is particular to the United Kingdom context and may not be being addressed by others;
- To take account of newly arising issues that are relevant, such as the likely complex accounting environment associated with the interim financial reporting regime from 2005.
- To comment on questions principally of a finance and investment nature;
- To make a useful contribution to the development of supervision practice in the UK context of a single financial regulator intending consistency of approach.

It will definitely be the aim of the working party to be as fully aware as possible of the work of others and not to duplicate this."

We hope that this report, which we regard as a work in progress, will prove to be a valuable resource to actuaries and others with an interest in management and supervision of financial firms. We

gratefully acknowledge supporting work, particularly Ed Stumpf's work on economic models, Anthony Bentley's analysis of other supervisory regimes, and the willingness of Barrie and Hibbert to make simulations available for the purposes of this report.

Members of the working party contributed to this report in a strictly personal capacity, and any views expressed herein are not to be taken as those of the UK Actuarial Profession, of members' employers, or of any other body with which a member may be associated.

EXECUTIVE SUMMARY

BANKING AND INSURANCE

The quality and quantity of thought devoted by firms, supervisors, the academic community and others to the 'Basel' supervisory regime for the banking industry has been prodigious, exceeding by many times the effort expended in the insurance or investment sectors (even though the insurance sector had a harmonized minimum capital requirement within Europe long before Basel). The Basel II accord will both represent a major achievement for international financial stability management and will create an impetus for its own replacement by something better.

The supervisory regimes and philosophies for financial firms must converge in parallel with the progressive breaking down of historic functional divisions in the marketplace. This should imply drawing on the intellectual investment in Basel in combination with the knowledge developed mostly by actuaries in the insurance context.

This is an important endeavour, as the supervisory philosophy will define the trade-off between considerations of confidence and stability and competitiveness – optimally or otherwise.

ECONOMIC CAPITAL MANAGEMENT PROCESS

Best practice on the part of leading banks and a growing number of insurers is the establishment and continuous refinement of economic capital management. Economic capital management is the business process whereby the financial resources required to meet negative outcomes with a defined and consistent confidence or shortfall level are determined, put in place, and communicated to stakeholders.

The value of such a process is that it reinforces continuous improvement in risk management, including particularly development of risk mitigation techniques. Risk management is integral to the competitive strategy of financial firms.

GOVERNANCE CONTEXT

The technical challenge of economic capital definition and its oversight by supervisors are at the heart of this paper. In truth, however, the economic capital process as defined here is part of governance. Management commitment to a process that is applied consistently across pricing, financial reporting, and performance measurement and management is more important than the precise detail of the formulae. We believe the supervisory regime should encourage firms to develop their own processes, and that diversity of means to a common end is to the public advantage.

PILLAR 2 AND PILLAR 1

There are subtle but important differences of emphasis between parts of the supervisory, academic and practitioner communities across the financial sectors as to how the interaction works as between:

- Pillar 1 – the quantitative minimum capital requirement for firms generally; and
- Pillar 2 – the supervisory dialogue giving rise to a firm-specific capital requirement.

Is Pillar 1 the critical element of the regime, with Pillar 2 as a supplementary element covering less quantifiable risks? Or is it Pillar 2 which is the critical judgement, with Pillar 1 as setting a context for that judgement which as far as possible assures fair play? We believe the complexity of modern financial services leads inevitably in the latter direction, which is a challenge for firms and supervisors alike.

ROLE OF ACTUARIES

The evolution of convergent supervision of financial resource adequacy will accelerate rather than slow down, and all financial sector firms will be assessing the effectiveness of their risk and capital management strategies and implementation. Some of this work to which persons with 'actuarial' skills in analysis and modelling should be able to contribute will include:

- Data gathering and analysis, probably including some collective effort analogous to the Continuous Mortality Investigation;
- Design and operation of risk mitigation and diversification strategies, including dynamic hedging and innovative approaches to reinsurance;
- Investigation and assessment of actual and potential non-stationary influences across all the range of economic and hazard risks (including risk correlations and dependencies);
- Continued development of coherent risk measures and of stochastic risk modelling techniques across the various forms of risk;
- Investigation of cyclical influences and development of contra-cyclical risk measures;
- Further development of capital market solutions, including risk securitisation and new forms of financial instruments;
- Support for the supervisory community in assessment of firms' economic capital management processes.

In these areas and others, the actuarial contribution will be most effective in active co-operation with other disciplines. We believe, as do most of the world's leading actuarial professional bodies, that risk and capital management in financial firms is an important emerging discipline to which we must seek individually and collectively to contribute.

SUPERVISION OBJECTIVES AND DIFFICULTIES

PUBLIC AND POLITICAL INTEREST

In most developed economies, it is generally accepted that organisations acting in a fiduciary role in relation to the [savings of the] general public should be subject to some form of public supervision. The original and core purpose of supervision was to compensate for information asymmetries which could cause funds placed with an institution to be at risk of loss through mismanagement or fraud. Supervision of banks has traditionally recognised that there is risk associated both with their deposit-taking activities and with their money transmission activity. Supervision of both life and general insurance companies has evolved substantially in tandem and until recently quite separately from supervision of banks. Both types of insurer have in common a promise to provide customers with funds in time of need.

As well as the supervision of individual firms for sake of protection of their individual customers, there is a widely held view that economic efficiency requires an effective supervisory process for all firms performing particular functions. Supervision has the potential to sustain confidence in financial institutions and thus to facilitate private saving which is generally regarded as conducive to economic growth. Indeed this has come to be regarded as a principal purpose of modern financial supervision, which is expressed as intended to maintain the confidence of the reasonable public at large in the system, while allowing at least some theoretical risk of failure of some individual firms.

The benefits of supervision are not negated by the prevalence of insurance or compensation schemes, public and/or private, which meet some or all of [smaller] losses arising from failure of a financial institution. Such schemes depend on a framework of disclosure or supervision in order to work.

At least one developed economy takes the view that active public supervision can be replaced by a combination of disclosure to private rating agencies and compliance with ratios and by vigilance on the part of customers. New Zealand has implemented a regime of this form.

NON-ZERO FAILURE – PRACTICALITY

It is conventionally recognised that no feasible supervisory process can completely preclude failure of every single firm. Alternatively any process with this objective is accepted as being likely either to impair competitive innovation and efficient business management or to impose excessive cost on customers. It has however proved more difficult to define any tolerable level of risk associated with an effective supervisory regime, beyond specifying that the theoretical possibility of failure of an individual firm should not be such as to shake the confidence of reasonable members of the public in the financial system generally. This is usually understood as implying that supervision should limit the theoretical risk of failure to relatively smaller firms the failure of which should not impinge on the finances of others.

SYSTEMIC RISKS AND 'TOO LARGE TO FAIL'

There is an extensive literature on the difficulties and risks associated with the objectives of supervision as interpreted in the preceding sub-sections (see bibliography). Specifically the threats to solvency of financial institutions are highly correlated and result from wider macroeconomic influences, such as asset price 'bubbles' and 'depressions'. It is also recognised that the drawing of a definite distinction between firms at risk of failure and those for which failure is 'unacceptable' would have the potential to create moral hazard and to distort competition.

The banking sector is particularly exposed to systemic risk both by virtue of its credit creation activity and because the effects of failure of one institution can through money markets and the payments system have negative consequences for others. This has in the past resulted in the imposition of constraints on the scope of activities of certain types of bank.

The insurance sector is much less exposed to similar influences, although a significant shift in the macroeconomic context can create systemic stress as illustrated historically in, for example, Japan and currently in several European markets. Reinsurance has the potential to create widespread losses or spiralling of losses with adverse impact on confidence generally, as has recently been commented upon by the IMF and OECD.

REDUCED FUNCTIONAL BARRIERS / CONGLOMERATES / UNIFIED SUPERVISION

Developments in the technology of finance have eroded traditional functional distinctions between types of financial institution. These developments have been reinforced by a global trend away from prescriptive regulation of activities and towards freedom of competition subject to supervision.

It is quite usual for the modern retail financial institution to seek to satisfy all the financial service needs of a substantial proportion of its served public, including reserving the strategic choice of acting as principal or intermediary in relation to the range of product types.

These trends have both necessitated and facilitated a parallel erosion of previously distinct approaches to supervision. To varying degrees, major developed markets have been implementing integrated financial supervision. A growing attention to global financial stability following a series of crises has reinforced this trend.

SUPERVISION MUST BE NATIONAL AND INTERNATIONAL – LATTER ONLY CANNOT WORK

The trend from prescriptive regulation to supervised competition, together with the growing integration of the global economy, has generated an international dimension to supervision of financial institutions. The growth of multinational firms with implicit dependencies has reinforced the urgency of this. The motivations have included both 'fair' competition and the avoidance of instability resulting from a 'dash to the bottom' in terms of regulatory arbitrage. The substantial elimination of controls on flows of capital has made a common international regime an urgent issue for the banking sector in particular. Equally the arguments already identified for supervised competition as a spur to economic growth apply across national boundaries as well as within them.

There are some differences of view as to whether the international dimension is an overlay of standards on existing national approaches or is a potential substitute for national supervisors – at least within some or all of the countries of the European Union. In practice the former is currently the case and this seems unlikely to change any time soon, given domestic political sensitivity to public confidence in retail financial firms.

EVOLUTION OF BANKING SUPERVISION

TRADITIONAL CENTRAL BANK SUPERVISION

The disastrous economic consequences of banking system failure have been sufficiently demonstrated to be well understood as best avoided. In many markets the regime has been one of regulation to limit unsafe competition supported by central bank supervision. This fitted naturally with the traditional role of the central bank as supplier of liquidity ('lender of last resort') – lack of liquidity being a principal threat to bank solvency.

Supervision is the apt term for the activity of central banks, which generally sustained an active and continuous dialogue with bank managements with a heavy emphasis on asset diversification and quality, questioning of operational risks associated with business developments, and so on.

In some markets and/or for some types of bank, the role of supervisor was separate – for example the Building Societies Commission supervised some very large limited-scope banks in the United Kingdom.

DEREGULATION LEADING TO THE BASEL ACCORD(S)

The change of emphasis from regulation to supervised competition is mostly a feature of the last quarter of the 20th century, and was not limited to the banking industry. This coincided with the first steps to mobility of financial capital and the integration of international currency markets in particular.

The principal economic players (G-10) recognised that standards were required if banks were to compete internationally. National financial supervision regimes had evolved independently, and the weaker regimes could enjoy a competitive advantage. A likely consequence would be that banks with international aspirations would find ways to locate growing proportions of their activities within 'weak capital' jurisdictions, posing a threat to international financial system stability.

There was also at the time a recognition of the need to increase capitalisation of the international banking system generally, in that resources which had sufficed in an era of regulation would be unlikely to be sufficient for supervised competition.

For all of these reasons, a committee was established under the auspices of the Bank for International Settlements (BIS) in Basel resulting eventually in agreement on an accord [the Basel Capital Accord 'Basel 1'] to apply to banks operating internationally taking effect in 1988. At the core of the first Basel accord was a standardised approach to credit risk whereby weights were applied to particular asset types (for example, a 50% weighting for residential mortgages) in the context of aggregating to a total 'risk-weighted' assets amount to which an 8% minimum capital threshold was applied. Very importantly, although the accord formally applied only to banks operating internationally, similar requirements were introduced within national regimes to apply to most banks.

Basel process

The 1988 accord initiated a capital adequacy standard-setting process for international banks (and indirectly for other banks) which continues today. The principal evolutionary development was the addition of a capital requirement in respect of market risk within banks' trading books based on the

'value at risk' approach originally pioneered by the JP Morgan bank. This change was implemented in [1996].

Basel also standardised the definition of capital in two tiers:

- Tier 1 consisting of equity and disclosed reserves; and
- Tier 2 consisting of undisclosed reserves, revaluation reserves, general loan loss reserves, and some qualifying hybrid debt capital instruments and subordinated term debt.

Commentators generally praise the Basel process as a mechanism whereby best practice in assessment of economic capital adequacy is spread from the most advanced banks to the international banking system generally.

QIS

A particular strength of the Basel process is that of quantitative impact studies (QIS) whereby the impact of an envisaged change or development is assessed and refined by research within a substantial sample of banks. By this means the regulatory requirement can be reconciled to the 'true' economic requirement as assessed by leading banks.

FROM BASEL I TO BASEL II

Although the Basel I accord is widely recognised as successful in eliminating the potential for jurisdiction arbitrage and in improving the stability and efficiency of the international banking system, it has inevitably generated a momentum for its own improvement as the most sophisticated banks arbitrage between the regulatory requirement and the true economic capital requirement. For example the crude classification of assets for risk weighting purposes has the potential to 'push' weaker banks towards adding a relatively high proportion of the riskier asset types within each class. There is therefore a natural dynamic of refining the accord to correspond more closely with the differential risk assessments of the most sophisticated banks.

Thus there was a natural consensus embracing both supervisors and banks for the development of a new accord which would be:

- Broader in scope, to embrace all of credit, market, and operational risk;
- More risk-sensitive, taking account of market-leading risk evaluation practices;
- Enhancing confidence in the system – maintaining at least the existing level of capitalisation in aggregate relative to risk exposures; and
- Including incentives for further improvement in risk management techniques and disclosures.

Although not yet finalised in detail, the shape of the Basel II accord is described and critiqued here. A 'final' consultative document (CP3) was published in April of this year for implementation at the end of 2006.

Increased scope

Basel II will embrace all of credit risk (most important for most commercial banks), market risk (trading book only, important for investment banks), and operational risk in the determination of capital requirements. It will not explicitly address, for example, strategic risk or reputational risk. These latter risks are acknowledged to be real but not easily quantifiable.

There has been much debate about the inclusion of operational risk in the Basel framework. The argument of objectors has been that operational risk is a management rather than a funding issue. The argument which has prevailed is that it is appropriate that firms should be incentivised better to mitigate and manage the operational risk in their business.

Three pillars

The Basel II framework introduces explicitly for the first time the three pillars of the edifice of supervision:

- Pillar 1 is the risk-related minimum capital requirement;
- Pillar 2 is the process of supervisor examination and dialogue whereby management is influenced to manage particularly the less easily quantifiable risks; and
- Pillar 3 is the requirement to disclose externally information which can allow the market to distinguish between organisations which are more or less effective in managing risk.

Relative importance and how this is likely to evolve

As noted above, Basel I concentrated on formulaic capital requirements (Pillar 1) in order both to reduce potential for arbitrage and to improve banking industry capitalisation worldwide. There are differences in the relationships between banks and their supervisors (Pillar 2) in various jurisdictions reflecting history and culture and the degree of linkage of a particular market with international markets generally. Pillars 1 and 2 are very complementary in that many of the influences which appear to cause banks to fail are those which ought to be visible to experienced supervisors. Thus there is an ever-growing emphasis on understanding the operation of systems and controls, including how banks themselves think about the financial resource requirements associated with particular risk profiles.

The theory that supervisors' efforts could be leveraged by informed rating agencies, holders of subordinated debt, and counterparties (Pillar 3) is attractive. In practice, this discipline has yet to establish itself, and there are those who believe that Pillar 3 will not match the first two in importance.

Pillar I – from basic to advanced approaches

The universe of banking firms embraces a wide variety of sophistication, from a Citigroup at one extreme to small community savings banks at the other. There are corresponding differences in firms' willingness and ability to form their own view of the financial resource requirement associated with a particular risk appetite. The extension of the original Basel accord to embrace market risk

included provision for banks to base their required capital on their own risk models, subject to certain criteria (including that the model be used integrally in managing the business).

Although a relatively small number of banks have sought and secured CAD approval, the perceived success of the framework has led to its adoption in relation to other categories of risk as follows:

	Market risk (trading book)	**Credit risk**	**Operational risk**
'Beginner' (smaller firms)	Standard Method	Standardised Method	Basic Indicator approach
Intermediate		Foundation IRB Approach	Standardised approach
Advanced (money centre banks)	Internal models approach	Advanced IRB Approach	Advanced modelling approach (AMA)

A CRITIQUE OF BASEL II

POTENTIAL FOR INCONSISTENCY IN OPERATION OF PILLAR 2

The practical operation of banking supervision differs (or is certainly perceived to differ) between national jurisdictions, for example in the closeness of supervisory oversight and the timeliness of reviews of asset quality. This has stimulated some concern that the inclusion of Pillar 2 within Basel II will dilute efficacy in relation to the fair competition objective.

CONCENTRATIONS AND RISK INTERACTIONS

Perhaps inevitably, it has not been possible to anticipate in Pillar 1 all the potential for interaction and concentration of risk. Although Pillar I is not defined so as to assume, for example, that market and credit risk are independent, it is expected that assessment of interaction and correlation will fall within Pillar 2.

POTENTIAL FOR PROCYCLICALITY

The potential for Basel II (specifically the credit risk modelling element) to exaggerate the boom and bust of the economic cycle has been a subject of controversy throughout the development of the Accord, and has been recognised by its architects. It is to be expected that this dimension will be the subject of continuing debate as the Accord is implemented.

IMPACT ON EMERGING MARKETS

The adoption of a 'realistic' approach to sovereign credit is a clear change as compared with Basel I. Some critics argue that this will inappropriately curtail bank lending to emerging sovereign borrowers contrary to what may be in the best longer-term interests of the global economy.

RISKS OF ANTISELECTION AS BETWEEN STANDARDISED AND MORE SOPHISTICATED APPROACHES (OR BY LINE OF BUSINESS)

There is some risk that sophisticated firms will adopt sophisticated approaches only where they have reason to believe that these will result in a lower capital requirement, thereby weakening the strength of the industry in aggregate. This would arguably be short-sighted, and the accord will constrain the reduction allowed to organisations in practice. This risk may however explain the intention of US regulators to require internationally operating banks to adopt the most sophisticated modelling approaches available across the board.

CAN RANDOM VOLATILITY AND ULTIMATE UNCERTAINTY BE DISTINGUISHED?

The philosophical basis of the accord takes into account fluctuations in experience – whether random market movements or cyclical economic fluctuations about a stationary mean. If the mean itself is uncertain, or if the experience is non-stationary, the accord principles arguably are invalidated. While this may not be relevant to banking, it would be an issue in adapting the model to the insurance context.

CREDIBILITY DIFFICULTIES FOR SMALLER FIRMS

The approach taken under Basel II of offering advanced modelling options for both operational risk and certain forms of credit risk means that data credibility can become a source of competitive advantage. All other things being equal, this means that larger organisations enjoy an advantage as compared with smaller firms. This has the potential to create at least political friction, and arguably runs counter to macroprudential objectives.

COMPLEXITY

As Basel II has evolved, it has gathered much detail, particularly in relation to advanced modelling approaches, which in turn has attracted criticism regarding complexity. Thus the current intention of the US regulators is to make the full-blown Basel II approach mandatory only for internationally active banks (and not to allow these to opt for any less sophisticated approach).

Basel II is complicated by an arguably old-fashioned approach of expressing the exposure to all forms of risk in terms of an equivalent credit risk exposure – every form of risk enters into the determination of the risk-weighted assets amount to which the adequacy ratio is then applied.

'BOOK VALUE' ACCOUNTING BASIS

The Basel accord is applied against the background of historic cost accounting for the bulk of bank assets and liabilities, and it appears unlikely that these will be restated to fair value any time soon. This has the potential to frustrate the intentions of the Accord, insofar as the net assets on an historic cost basis may not be a measure of realistic uncommitted economic resources. In practice it appears that the dominating potential for mis-statement relates to poorer quality assets (as is widely the case at present in Japan).

INCLUSION OF OPERATIONAL RISK

Some banks – for example those whose business has unusually substantial processing dimensions – have sought to argue that a capital allocation requirement is an inappropriate way to take account of operational risk. These organisations argue that operational risk is better dealt with in Pillar 2 rather than as an element of Pillar 1. The counter-argument is that the leading exponents of economic capital allocation do attribute a capital requirement to operational risk, which creates an incentive for effective management of that risk.

ARE MORE SOPHISTICATED APPROACHES TOO PRESCRIPTIVE?

The shape of the accord is likely to reflect best practice in bank capital management at the time it is finalised, but this is a rapidly evolving field. Some commentators argue that the accord will rapidly become obsolete in ways which we cannot now foresee, and that a better approach would be to focus on enduring principles rather than on prescriptive detail. Others take the view that this would be impractical for an agreement intended to apply globally.

Despite convergence in technology and integration of supervision across financial services, insurance business risk management has evolved substantially separately from its banking counterpart. Emphasis and techniques also differ as between life and general insurance.

LIFE ASSURANCE

Life assurers accept contracts which to varying degree promise payment on the happening of adverse events or on survival. The relative significance of different risk drivers depends on the actual and desired business profile(s).

HAZARD

Contracts may be fixed, precluding review or change, or variable. Effective risk management includes pricing (where relevant, repricing) appropriately to the served market, clarity as regards risk selection and rating, and clarity as regards admission and payment of valid claims. Additional dimensions include recording of data which facilitates steady improvement in sophistication of pricing, the avoidance of risk concentrations, and the arrangement of an effective reassurance programme. Group business carries with it the need to underwrite at the group level.

Mortality

Much revolves around a clear view of the market to be served and/or how it is to be served and rapid preliminary assessment of the terms for a particular risk.

Morbidity

Management of the claims process so as to pay only valid claims and only for so long as these continue to be valid is usually a key issue. There is a correlation with the economic context so that, for example, diversification across occupational groups is important.

MARKET

Life assurance is a commitment to pay fixed or variable amounts in specified circumstances. This commitment may endure over a very long period of years. There is a risk that the proceeds from invested assets to be used to pay the liability may be different from the amount anticipated at the time of entering into the commitment.

Where the commitment is fixed in monetary terms, deviation can arise owing to:

- Lack of availability of assets producing funds on the dates required to meet the liability; or
- Discretionary investment in assets other than those which would produce funds on the dates required to meet the liability.

- In the case of a commitment to pay a variable amount in accordance with a certain algorithm, the risk is that the algorithm may be invalidated by changes in market circumstances.

Effective management of market risk is characterised by clarity of structure and authority, with the ALM function established independently of others, with well defined authorities monitored on a timely basis, and with effective reporting lines to management. Disciplined ALM strategies, including hedging, are associated with the leading players. As recent events have shown, this is potentially the most significant source of risk for most life assurers.

CREDIT

Credit risk in life assurance is associated principally with default on obligations by borrowers in the context of quoted securities, unquoted loans, and real estate rental. There may also be some credit risk insofar as commissions may have been advanced to intermediaries in advance of their being earned.

Credit risk is typically managed by seeking to optimise diversification – across industries and across borrower status. There is some evidence that optimum diversification is a function of position within the recurrent economic cycle.

OPERATIONAL

Operational risk is conventionally defined as the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events. This definition is not at all unique to life or general insurance. Operational risks in life assurance which have proved substantial in several contexts include failures in the sales process, contract drafting deficiencies, problems with pricing of units and so on.

Management of operational risk is about identification of risk drivers, collection of loss data, and continuous refinement of the assessment of potential loss frequency and severity. Effective management also involves focused effort to mitigate the potential consequences of the most severe risks.

GENERAL INSURANCE

HAZARD

Hazard risk in general insurance can be very heterogeneous. For many lines, the laws of large numbers provide some protection as regards loss frequency, although loss severity can be impacted by environmental developments for example changes in medical technology and their impact on bodily injury awards.

For low-frequency events the issues become different, and most insurers will themselves be purchasers of coverage to limit their exposure to various forms of catastrophe. The insurance market depends on mechanisms such as the slip system to spread the very largest risks over the greatest possible number of risk-takers. In general insurance, management of reinsurance and of (gross and) net exposures is of critical importance. Claims management also is important, both as regards timely payment of valid claims and denial of the invalid.

MARKET

Insofar as a principal liability of general insurers is payment of claims intended to compensate for actual loss, inflation will be relevant. This may be either or both of general cost or earnings inflation or of inflation in a particular dimension such as medical care. Specialised classes, for example mortgage indemnity, may be very directly exposed to economic influences.

CREDIT

As well as the credit risks already referred to in relation to life assurance, it is typically a feature of the operation of general insurance companies to be exposed to:

- Credit risk in relation to intermediaries who may have been allowed to hold money on the insurer's behalf; and
- Counterparty risk in relation to reinsurers on whom the primary insurer may depend in order to meet its own claims.

Credit risk management typically includes monitoring and management of exposures, requiring security as may be appropriate and feasible, and seeking to achieve diversification.

OPERATIONAL

Operational risk in general insurance is substantially inextricable from claims costs, in that much of the potential for loss arises from action on the part of policyholders or on the part of others playing a role in the claims process.

OWNERSHIP STRUCTURES – MUTUAL AND PROPRIETARY INSURERS

Occasionally the argument is advanced that differences in approaches to risk and capital management may be justified as between insurers operated on a membership basis and those owned by shareholders which can raise capital on the markets. The counter argument is that shareholders are unlikely to find it attractive to subscribe capital to restore solvency after unexpected losses, while members may find it in their interests to subscribe further to sustain their collective enterprise. In practice, much is likely to depend on the reasons for any losses and on the future prospects, as well as on any wider reasons for member solidarity. The norm is to have equivalent standards as to risk and capital management as between mutual and proprietary firms.

ASSET-LIABILITY MANAGEMENT (ALM)

Quality of asset-liability management is an important dimension of effective risk and capital management for most financial service firms, especially banks and investment-oriented life insurers. This is in large part an issue of governance – beyond the scope of this paper – but there is also a significant quantitative technical dimension.

SCENARIOS AND STOCHASTICS

At the core of ALM is a process of analysis of the impact on the values of and cash flow amounts associated with both assets and liabilities arising from changes in economic and financial

circumstances. Conventionally substantial proportions of life insurance liabilities will be path-dependent i.e. expected cash payments will be a function not only of asset value as at the time the payment is due, but also of the path followed to reach that point. Modern practice is to explore development both having regard to specific scenarios (often a range of these is specified within the supervisory process) and also using stochastic simulation whereby movements reflect an assumed probability distribution.

HEDGING STRATEGIES

Particularly in the case of life assurance, liabilities include complex options – examples are guaranteed minimum death benefits, guaranteed annuity rates, guaranteed encashment values, guaranteed minimum accumulation etc. Offices may seek fully or partly to hedge the risk to solvency posed by such a guarantee. While no hedging strategy is perfect, offices will commit to hedging in the reasonable expectation of some relief from the capital requirement otherwise associated with differential movements in assets and liabilities.

HAZARD RISK DIVERSIFICATION

Risk diversification is a key theme in insurance business management, which depends on the volatility of the mean of a large sample of independent risks varying inversely as the square root of sample size. In practice there is always some element of correlation associated with catastrophe, secular change or other systemic influence. For example the tragic events of September 11 underlined the potential risks of concentration of group life insurance risks.

There is debate as to whether diversification across classes of insurance is of real benefit – for example does an office benefit from running both household and motor portfolios, all other things being equal? We take the view that while diversification in this way may reduce volatility of results, it is not necessarily as advantageous to shareholder value as operating a larger well-diversified portfolio of either class alone.

A COMPARISON OF THE DEVELOPMENT OF INSURANCE SUPERVISORY REGIMES INTERNATIONALLY

We will not seek to repeat here the surveys and reviews of insurance supervisory practice variously conducted by supranational bodies such as the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD), and the International Association of Insurance Supervisors (IAIS). The range of such surveys testifies to the growing importance attached to effective supervision of insurance (and banking) for sake of financial stability, particularly following the 'Asian crisis' of 1998. Instead we focus on key developments in several jurisdictions – often as a response to emerging problems – which seem most important as indicators of improving practice.

AUSTRALIA

The Australian Prudential Regulatory Authority (APRA) operates distinct regulatory regimes in respect of each of life and general insurance. The latter has had most development attention, in response to identified solvency problems at some major insurers. Key features of the current regime, implemented with effect from 1 July 2002, are a minimum capital based on a risk based capital formula, a probabilistic standard for adequacy of technical provisions and an option to allow internal company models to be recognised by the supervisor for the purpose of assessing capital adequacy.

The APRA standard is that technical provisions should be 75% adequate i.e. one chance in four of insufficiency. using a quasi – fair value basis (i.e. discounted claims reserves). Credit for diverisifcation is allowed in the assessment of the 75th percentile of the technical provisions. At this stage it is not yet entirely clear how this is to operate in practice, particularly for lines with low claims frequencies. We also understand that no insurer has yet sought to have its own internal capital model recognised by APRA.

CANADA

The Office of the Superintendent of Financial Institutions (OSFI) regulates Canadian insurers at the federal level, and operates distinct but parallel regimes in respect of both general and life assurance. OSFI has been a leader in requiring insurers to conduct dynamic analysis of capital adequacy (subject to a risk-based minimum) and in developing standards for provisions and capital adequacy for guarantees associated with investment-linked business. These developments were stimulated mainly by recent problems in the life assurance sector.

OSFI relies heavily on the professional competence and standard of actuaries and on the guidance processes of the Canadian Institute of Actuaries. Firms are obliged to request dynamic analysis reports which in turn are made available in confidence to OSFI. OSFI has exerted pressure to improve the standard of reporting. The Canadian profession has been to the fore in implementing probabilistic models of asset performance. Importantly, the profession made a conscious decision to prescribe a standard of model calibration rather than seek to prescribe the form of asset model.

EU COUNTRIES

Insurance supervision in the European Union is the responsibility of national supervisors – to an increasing degree these supervise all financial institutions, although some specialist insurance supervisors survive. There is a contrast with the banking sector where the Union adopted a directive applying the first Basel accord to all banks. The Union (formerly the Economic Community) has implemented a series of directives requiring, inter alia, common minimum solvency margins to be overlaid on asset valuations and provision amounts calculated according to national rules. These national rules have themselves been in constant development in response to changes in the economic and financial environment.

This piecemeal development is widely recognised as at best inconsistent with the objective of a single European market for insurance, and the European Commission has therefore – in conjunction with the national supervisors collectively- embarked on development of a more coherent regime ('Solvency II'). The intention is that this should draw heavily on the three-pillar structure of Basel II and should also be associated with implementation of consistent accounting by European insurers generally under the forthcoming International Financial Reporting Standard for insurance. Implementation is currently envisaged for 2007, although national developments may effectively anticipate this.

US

The National Association of Insurance Commissioners (NAIC) is the forum for development of prudential regulatory standards to be adopted by the individual states. During the early 1990's, the NAIC evolved common risk-based capital standards for each of life, property and casualty, and health insurance. These include factors to be applied to various measures of exposure corresponding

to four principal types of risk (market risk, insurance risk, default risk and business risk). The detail of the approach has been the subject of constant minor change.

At time of writing it appears likely that the NAIC will follow the Canadian precedent of requiring a model to be used for assessment of capital required to support various forms of guarantee in relation to variable business.

UK

The fall-out from the very visible difficulties of the oldest, and one of the biggest, life insurers has acted as one stimulus for comprehensive and rapid development of UK insurance supervisory practice. Equally important have been the integration of financial sector supervision in the Financial Services Authority (FSA) and the recent weakness of equity markets, which have traditionally been employed by UK insurers to a higher degree than in most jurisdictions.

Rather like the European Commission approach discussed above, the FSA has clearly committed itself to drawing as far as is appropriate on its evolved approach to prudential regulation of banks, which in turn is based on the Basel accords. Specifically, it expects insurers to conduct their own assessments of the adequacy of their capital resources to be reviewed by and with itself. New minimum capital proposals and a new capital assessment regime for both life and general insurance are expected to be exposed for consultation during summer 2003.

BANKING AND INSURANCE – SIMILARITIES AND DIFFERENCES

Bankers, insurers, and many commentators have argued extensively as to whether banking and insurance are more alike than different from a perspective of prudential regulation. We discuss some of the principal arguments here.

SUPERVISOR-RELEVANT DIFFERENCES BETWEEN BANKING AND INSURANCE

HETEROGENEITY

It is debated whether an insurance group bearing risks ranging from individual mortality to the potential failure of a communications satellite or even an earthquake is more heterogeneous than a bank operating in retail, commercial, and investment banking activities. It may be the case that the risks of financial loss to the bank are driven by many of the same influences as affect the insurer, even if the linkage is less direct. Specialisation arguably makes for a more heterogeneous range of insurance firms – for example there may not be a banking equivalent to a specialist catastrophe insurer.

LIABILITY UNCERTAINTY

The major part of the assets of most insurers will be securities of varying degrees of liquidity but capable of market valuation, while the liabilities will be uncertain as to timing or amount. In contrast, banking liabilities are usually well-defined, but the recoverability of assets involves at least some exercise of judgement. While this can seem a vast difference, the underlying position is that in both cases shareholders or own funds are exposed to risk and uncertainty.

ACCOUNTING

Arguably accounting for both banks and insurers is a distorted representation of the true economic position, with banking books recorded on the historic cost model, and the same model dominant in insurance accounting in most jurisdictions. It probably is the case that although distorted, there is greater consistency in accounting by banks globally than in the case for insurers. This is not universally true, as the balance sheets of Japanese financial institutions attest.

LIABILITY DURATION

From a market risk perspective, the duration of banking book liabilities is to the point at which rates may be reset, which ranges from overnight to several months with an average typically measured in days. Insurer liabilities in contrast typically are of a duration measured in years (months or years for most forms of general insurance, years and sometimes decades for life assurance). A possible implication of this difference is that while market risk models in banking may be dominated by the random character of short-term variations, there is an argument that the corresponding models for life assurance should reflect some concept of market equilibrium including reversion to trend.

ARBITRAGE ACROSS SECTORS

There is a growing awareness on the part of supervisors and those with an interest in financial stability of the risks of arbitrage. For so long as the potential exists for the same transaction to give rise to different capital requirements depending on the institutional context, there is a risk of specialisation leading to a weakening of the financial system generally.

This is a very topical issue, in that there appears to have been in recent years a significant migration of credit risk from the banks to the insurance and reinsurance sectors. Commentators suggest that this is a factor in the relatively low losses of banks to date in the current recession. There are signs of stress in insurers' holdings of credit derivatives and collateralised debt obligations (CDOs).

FIRMS AND GROUPS OF FIRMS

The traditions of banking and insurance supervision have evolved differently in that the focus of supervision in banking usually is the group, while insurance supervision focuses at a legal entity level (prior to the recent implementation of the Insurance Groups Directive).

EXPERIENCE IN THE BANKING CONTEXT

Banking supervision has been predicated on the view that the obligations of all banking subsidiaries are implicitly guaranteed by the group, and it is mainly the consolidated position which is reviewed by supervisors. It is usual for the implicit position to be backed up by explicit guarantees. Pending the detail of implementation of the Financial Conglomerates Directive, the position is less clear where a banking group owns a non-banking subsidiary, even an insurance subsidiary. In such cases the position may depend on the visibility of the association. It has on occasion been argued that the businesses were better kept separate – the supervisory quid pro quo was that the insurance business could not bear the name of the parent bank.

WHAT SHOULD GROUP SOLIDARITY MEAN IN ORDER FOR SUPERVISORS TO PAY ATTENTION TO IT?

The majority of multinational insurers argue that they should be supervised on lines similar to their understanding of the banking regime, with explicit guarantees of subsidiary liabilities. It appears that this is envisaged as substantially obviating the element of legal entity supervision, although it is less clear that supervisors conscious of obligations to their particular constituencies buy into this view. There are examples – notably the failure of Confederation Life – where the attitude of a national supervisor (in this case in the US) worked to the advantage of local policyholders at the expense of those of the parent company.

RISK MEASURES – ECONOMIC AND REGULATORY CAPITAL

It is appropriate to set some context for economic capital requirements as a measure of risk. We will describe banking practice and how this might be translated into an insurance context. For any financial firm, there are at least four 'levels' of capital:

- Regulatory capital – the bare minimum you ought to have in order to be allowed to continue in business (there will usually be a 'target' above this breach of which would be likely to prompt the supervisor to seek remedial action). This is usually the result of some formula (rather elaborately in the context of new Basel Pillar 1).

- Rating capital – a level of capital required to sustain a desired rating from the independent agencies.

- Economic capital – the amount of capital which on the basis of all you know about your business, is sufficient to a target degree of confidence (although the degree of confidence is likely to be related to the period over which it is measured). Ideally this will be an aggregate across all risk sources, having regard to potential interactions.

- Actual capital – the actual amount of capital at the disposal of the firm.

Ideally regulatory capital will be the lowest and actual capital the highest of these, with all of rating capital, economic capital, and (where relevant) threshold capital all in between and approximately equivalent.

BANKS AND ECONOMIC CAPITAL

Many banks operate an economic capital management process, which can be defined as the business process whereby the financial resources required to meet negative outcomes with a defined and consistent confidence level are determined, put in place, and communicated to stakeholders.

Depending on the nature and mix of a bank's business and on its risk appetite, the details of economic capital measures will differ, but the broad form is of an amount sufficient to assure positive net assets with a high degree of confidence over a defined period – broadly 'value at risk'.

This begs the question of the basis of measurement of asset values, where bank balance sheets typically are at book rather than fair value. In practice this theoretical weakness rarely invalidates the rationale for the chosen economic capital measure.

INSURANCE BUSINESS – COMPLICATIONS

As will be seen, the position is more complicated in relation to insurance business. As matters stand, assets and liabilities may be measured on bases well removed from fair value, and the dependence of the value of liabilities on uncertain assumptions about the future makes a 'period fair value at risk' criterion extremely difficult in practice (some of us think impossible). These difficulties are not insuperable in coming up with a workable definition of ultimate sufficiency – for example it is practical to think of a criterion which is based on ensuring that assets are sufficient to meet ultimate obligations with a sufficiently high degree of confidence. The position would be eased if proposals to implement fair value accounting for insurer balance sheets are carried through, although it is

important here to make the point that a workable definition of economic capital does not have to await implementation of fair value accounting.

ECONOMIC MODELS AND LIFE ASSURANCE

INTRODUCTION

The primary determinant of adequacy of financial resources in most forms of life assurance business with a material investment component is the potential for differential adverse movement in assets relative to liabilities in certain economic scenarios. The technique of simulating the development of assets and liabilities and applying a threshold confidence level was first introduced with the development of the Wilkie model to assess the resources required to meet performance guarantees in relation to unit-linked business in the 1970's.

There is a well-developed mainly North American literature on modelling of the term structure of interest rates appropriate to the context in which life assurance liabilities are backed mainly by fixed-interest assets. We have however concentrated on the equity risk which is usually a significant feature of UK with-profits business.

In this section we first discuss the key issues relevant to the assessment of capital and then present the results of a simplified model we have used to demonstrate their impact. Further details of the modelling and output are contained in the Appendix.

TIME HORIZON

One issue which presents itself is the form of test to be applied:

- Assets and liabilities may be projected from the valuation date over the remaining life of the portfolio, with the standard being defined as either a confidence level or a maximum conditional tail expectation of loss; or

- Values of assets and liabilities may be projected over a defined horizon from the valuation date, with the standard being a defined level of confidence that the value of assets should at least equal the value of liabilities (or, again, a maximum conditional shortfall).

While the latter is in some ways the more theoretically appealing approach, it does raise a question as to how the value of liabilities at the horizon is to be determined within the simulations.

The actuarial profession and supervisors in Canada and the United States have preferred the former form of test in relation to guarantee risk, while the recent white paper from the Dutch supervisor appears to prefer the latter more generally. The International Actuarial Association working party on definition of capital adequacy has recommended that both tests be applied.

In our view, this depends on the underlying model for asset performance and, in particular on the allowance for mean reversion therein. We believe that as a practical matter a sufficiently demanding confidence threshold measured over the long-term in the context of a slowly mean-reverting model should mean that the long run run-off test will normally dominate the shorter 'fair value at risk' threshold.

UK WITH-PROFIT BUSINESS

The United Kingdom is relatively unique among life assurance markets in the degree of discretion afforded in the management of portfolios of participating business and in the manner in which that discretion has been exercised. Due in part to an exceptionally volatile history of inflation between the late 1960's and the early 1990's, the practice has developed of substantial investment in equities with a significant proportion of the resulting 'profits' being credited to policyholders as a final ('terminal') bonus. In balance sheet terms, firms have been running unhedged mismatch positions supported by various forms of capital and by the right of directors to vary the manner of their exercise of discretion should circumstances warrant this (with the constraints of 'policyholders' reasonable expectations').

Concerns have grown that the risks involved in this class of business are not understood in the same way by the managers of firms, by policyholders, and by the supervisors. Historically capital adequacy was considered by reference to market value of assets and prescriptive rules for valuation of liabilities including a prescribed additional amount based on a stress test. Depending on the free assets disclosed as the result of such a test, firms were deemed to have greater or less freedom in sustaining a mismatched position. Many firms used simulation modelling (the Wilkie model in most cases) to assess the risks they were running.

The direction and pace of equity market movements over 2001 and 2002, coupled with supervisor insistence on clarification of the reasonable scope of discretion, has prompted changes in the financial management disciplines applied to this type of business. It seems likely that firms will be required to commit to principles and practices of financial management ('PPFM') which are intended to allow customers to have a clearer view of the likely benefits to be expected from their policies. The supervisor also is implementing 'realistic liabilities/solvency' with the intention that liabilities and free assets in respect of with-profits business should be determined on sound financial economic principles having regard to their path-dependent character. The combined effect of these changes is to add to the importance of consideration of capital adequacy and sustainable mismatching position in tandem, and the supervisor is expected to consult on guidance in these areas later in 2003.

EQUITY MEAN REVERSION

The capital requirements for with-profits and unit-linked business – before any allowance for committed hedging strategies – are crucially dependent on assumed long-run characteristics of markets, including in particular whether a mean-reverting tendency is assumed in respect of equity values and the volatility of those values and, if so, over how long.

Like the debate on the sustainable amount of any equity risk premium, the debate on mean reversion is probably not capable of definitive resolution, with the two sides of the argument broadly expressed as follows:

- In favour of mean reversion is that it seems reasonable over some long time horizon to expect equity values to be correlated with measures of consumption or of national income. It can also be 'shown' for the major developed country markets that there has been a symmetry of positive and negative variations about a notional trend line over long historical periods. Markets do appear also to display 'dual regime' regime characteristics in relation to volatility, with periods of relative stability punctuated by periods of high volatility.

- Against this can be argued survivorship bias, in that studies show some equity markets have been totally destroyed by political changes, conflict, or by hyperinflation. The recent performance of the Japanese equity market is an example which may make for

doubt on mean reversion. There is also a theoretical criticism that mean reversion would represent an opportunity for 'arbitrage', albeit over the very long term. Finally, the prices of longer-term financial derivatives do not suggest any tendency to mean reversion.

Our working party concluded that the most useful approach may be to remember that capital adequacy is a relative rather than absolute concept and that there may be little to choose between assuming mean reversion and an associated high threshold of confidence or using an arbitrage-free model with an associated lower level of confidence, provided that in either case the combination of assumption and confidence level fits with the preferred risk appetite relative to peers.

ECONOMIC SCENARIO GENERATION STANDARDS

The minimum standards of prudence to be used in economic scenario generation will require to be specified by supervisors as part of Pillar 1. The actuarial profession has already considered in more than one context what form these standards should take, where the principal alternative approaches might be:

- To recognize one (or more) model types as fit for purpose and to prescribe standards for selection of certain parameters; or

- To prescribe certain minimum standards particularly for dispersion of returns which the results from the model must meet (fatness of tails).

RECOGNITION OF HEDGING

The question of how to recognise the economic capital benefit of risk mitigation activity including hedging is an important one, which has been considered in most depth by the North American actuarial bodies and by the International Actuarial Association. As always, there are two levels to the question – recognition within realistic economic capital modelling and the likely more stringent criteria for recognition as an offset to any Pillar 1 requirement.

The issue arises mainly in relation to financial guarantees and options included within life assurance liabilities – guaranteed benefits or accumulation rates associated with contracts with a mainly equity or other path-dependent element, or guaranteed terms in a context where no exact matching asset may be available.

The principles which appear to command support among actuaries include:

- The economic capital requirement should be computed and disclosed to relevant stakeholders gross and net (i.e. the assumed benefit from hedging should be explicit);

- The simulation modelling should take account of the potential weaknesses of the hedging strategy – basis risk, uncertain volatility/correlations / term structure / customer behaviour etc.

- Hedging should be recognised for capital supervision purposes only if clearly supported by a continuing commitment on the part of management to the strategy which is to be pursued.

We support the summary recommendation of the American Academy of Actuaries as follows:

If the insurer is following a clearly defined hedging strategy, the stochastic model should take into account the impact of hedge positions currently held, as well as the appropriate costs and benefits of hedge positions expected to be held in the future. This recognizes that a hedging strategy may not require hedge positions to be held at a particular point in time; however, allowance for the impact of hedge positions not currently held is only permitted if the insurer is following a clearly defined hedging strategy approved by the Board of Directors, or an authorized committee. To the degree the hedge position introduces basis, gap or price risk, some reduction for effectiveness of hedges should be made.

MODEL OVERVIEW

In order to test some of the issues discussed above, we carried out runs with a simplified model of one type of life insurance business. We modelled the run-off of a single cohort of a 10 year unitised with-profits bond, as defined below. We used 4 different economic scenario generators to assess the amount of capital required to provide the guarantees on the product. These asset models are described in the next section.

Central Run Definition

Liability product

1 10 year UWP Bond
2 No charges
3 No expenses
4 No tax
5 Regular bonus at a fixed rate of 4%
6 Terminal bonus at maximum(0, asset share less the accumulated fund)
7 Shareholder transfers on a charges less expenses basis
8 Maturity benefit = MVA free payout at 10 years
9 No deaths
10 Lapses at 3% p.a.

Assets

1 Bond returns based on a 10 year rolling bond (derived by comparing ZCB prices for 9 and 10 year ZCB's each year)
2 Equity backing ratio 60%

General

1 Results shown for 10000 simulations
2 Discounted values calculated at 4.5% for all models - 4.5% represents average yield on a 10 year ZCB for all models at the start
These are calculated in this sheet and can be switched on / off as desired

Sensitivity

1 EBR 0%
2 EBR 30%
3 EBR 100%
4 Regular Bonuses at 50% of net investment return; Max change in bonus limited to 0.5% from year to year
and minimum and maximum bonuses set at 0% and 10% respectively
5 Regular Bonuses at 50% of net investment return; minimum bonus 0% and maximum bonus 10%; no further smoothing

ASSET MODELS

THE SMITH MODEL (TSM)

Model Description

Simulated asset returns are generated by five independent Levy processes. The standard deviations, correlations and higher moments of the asset returns have been derived from historical data taken over the past ten years. Flesekar-Hughston transforms are used to ensure positive interest rates, and the Heath-Jarrow-Morton approach is taken to modelling interest rates. The returns generated by the

model are before tax and no allowance is made for expenses. As annual simulations have been used for this exercise, the return on cash is taken to be the returns on a one year zero coupon bond generated by the model.

Calibration

The initial yield curve is fitted to the term structure of interest rates displayed by gilt-edged securities at the calibration date of 31 December 2002. The model incorporates a small positive term premium dependent on the term of a bond.

An equity risk premium of just below 4%pa in excess of cash returns has been assumed in the calibration used to generate the returns used in this section. That results in a mean real rate of return on equities of about 5.5%pa. The long term dividend yield has been assumed to be 3%, compared with an index dividend yield of 3.55% at the calibration date.

The standard deviation of the annual returns on equities from this calibration is 19.5%. The volatility (the standard deviation of log returns) of equity returns is about 18%pa.

Further statistics from the calibration are shown in the Appendix.

WILKIE MODEL

Model Description

Full details of the Wilkie model can be found in David Wilkie's 1995 paper "More on a Stochastic Model for Actuarial Use" published in BAJ Vol. 1 part V. For the purpose of the modelling work in this section, those sections of the Wilkie model relating to equities, long bond interest rates and short interest rates have been used to derive the simulations. Since inflation drives the other components of the Wilkie model, that part of the model has also implicitly been used.

The standard parameters of the Wilkie model were derived by statistical regression to data over a period of many years. Consequently they are not necessarily suitable unadjusted for use in current conditions. Some of the parameters have therefore been adjusted to reflect economic conditions at the end of 2002, and to try to ensure some consistency with the other asset models used in this section, which have been calibrated to conditions at 31 December 2002.

Calibration

The standard and the adjusted parameters used for generating the simulations are summarised below.

		Standard	Adjusted
Inflation	QMU	0.047	0.0225
	QA	0.58	0.58
	QSD	0.0425	0.02
Equities	YMU	0.0375	0.0341
	YW	1.8	1.8
	YA	0.55	0.55
	YSD	0.155	0.155

	DMU	0.016	0.009
	DW	0.58	0.58
	DD	0.13	0.13
	DY	-0.175	-0.175
	DB	0.57	0.57
	DSD	0.07	0.05
Long Bond	CW	1	1
	CD	0.045	0.045
	CMU	0.0305	0.023
	CA	0.9	0.9
	CY	0.34	0.34
	CSD	0.185	0.185
Short Rate	BMU	0.23	0.22
	BA	0.74	0.74
	BSD	0.18	0.18

The starting conditions in the adjusted model have been set to be consistent with the long term means in the above table. The above parameters produce a mean equity return over 10 years of about 7.0%pa, somewhat lower than that produced by the other models.

THE SCENARIOS SUPPLIED BY BARRIE & HIBBERT

Overview

The runs have been prepared by Barrie & Hibbert using a positive interest *2*-factor *Black-Karasinski* model for nominal interest rates and a *2*-state regime-switching model for monthly equity excess returns.

The calibration used is a 'best estimate' at end-December 2002. Different calibrations and different models will be appropriate to different types of application and term and where results are sensitive to a particular feature of returns distributions selected.

Calibration

The initial position of the term structure is fixed in line with the UK GBP swap curve at end-December 2002. A zero term premium has been assumed for the term structure i.e. there is no incremental return for investing at long (or short) maturity.

An equity risk premium over cash of 3.9% pa is assumed (2.4% pa in geometric terms).

Equity returns exhibit 17% pa volatility at a monthly measurement frequency, 19% pa at an annual frequency. Unconditional 10-year discount bond returns have volatility of 9% pa..

	T=1 year	T=10 years
E(Equity rollup)	1.0835	2.4705
Log [E(Equity rollup)] / *T*	0.0802	0.0904

E(Cash rollup)	1.0420	1.6468
Log [E()] / *T*	0.0412	0.0499

GLOBAL CAP:LINK ASSET SCENARIO GENERATOR

Overview of Global CAP:Link

CAP:Link is a global economic asset model, which models the core economic fundamentals of GDP, inflation and the yield curve. Scenario equity and bond returns are influenced by events in the economy. For every scenario, CAP:Link simulates an internally consistent set of economic variables and the resulting asset class returns.

The model is widely published, for more details see "Calibration of Stochastic Scenario Generators for DFA" by John M. Mulvey, Ph.D., François Morin, FCAS, MAAA, and Bill Pauling

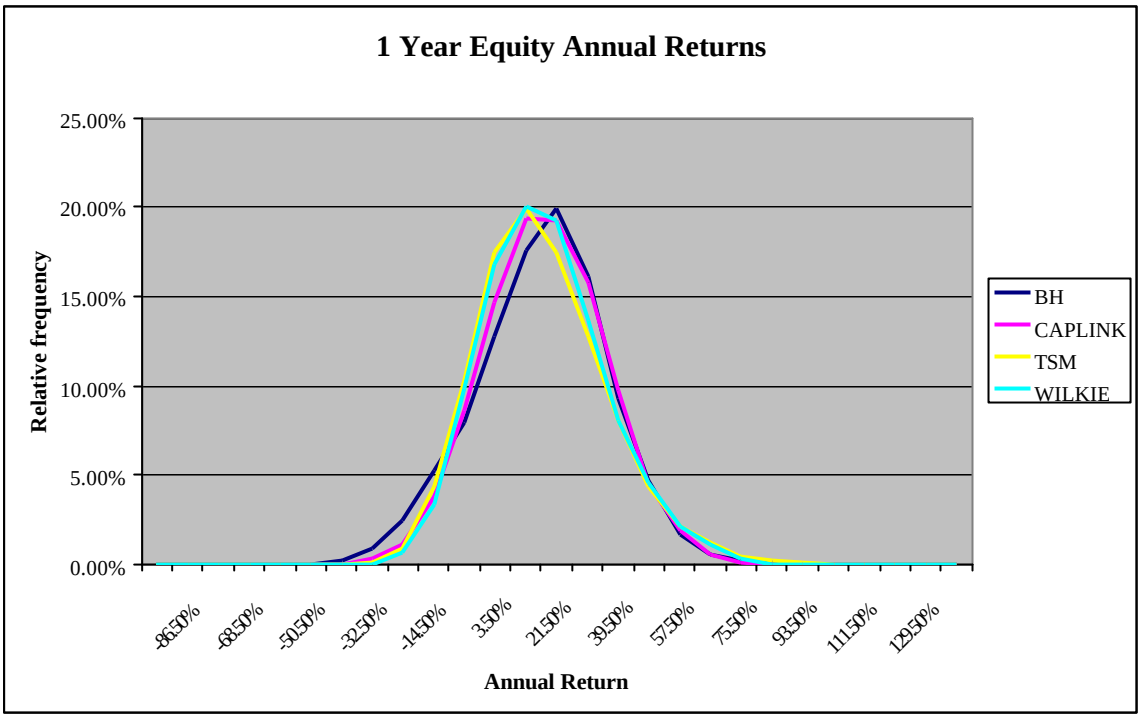
Calibration Used

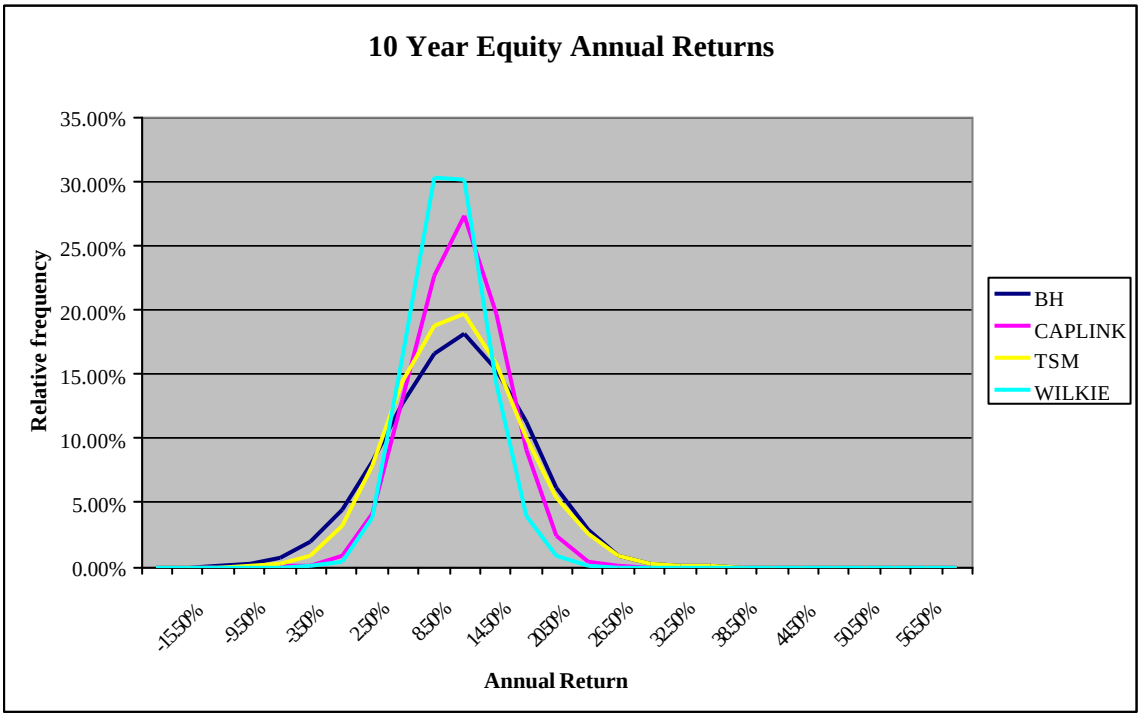
For this purpose, the model has been calibrated to exhibit 18% pa for the 1 year equity volatility and 11.5% pa for the 10-year zero coupon bond 1 year returns. The initial fixed interest term structure is fixed in line with the UK GBP gilt curve at 31 December 2002.

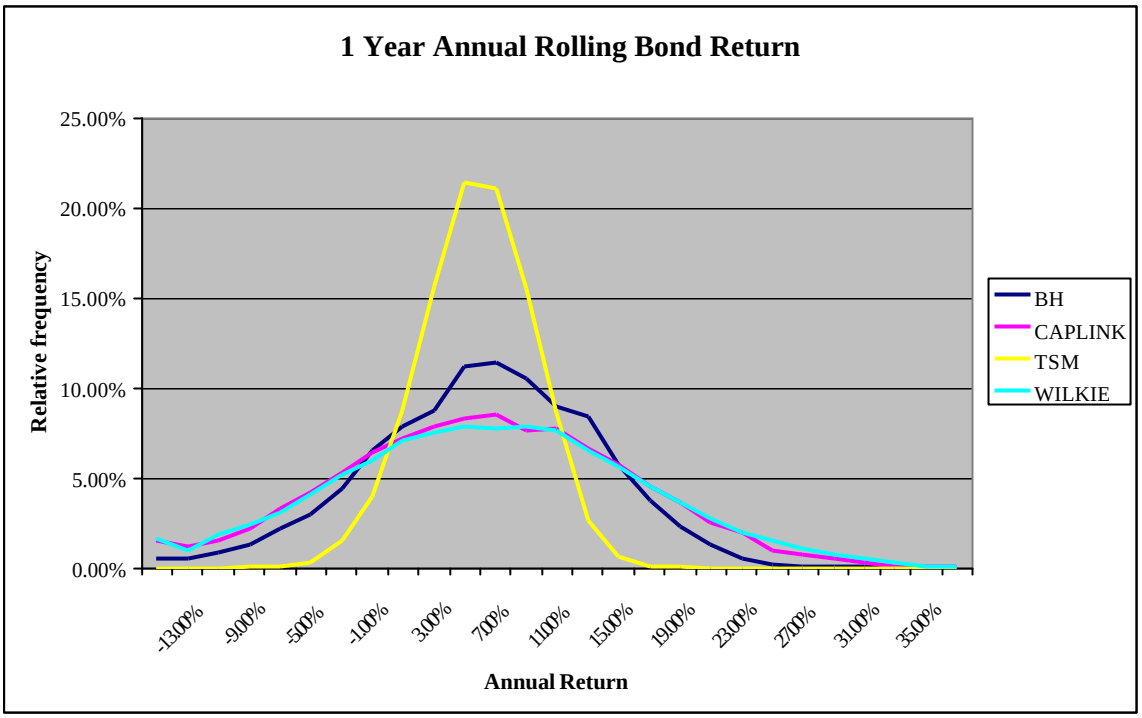
However, different calibrations would be appropriate for different modelling purposes.

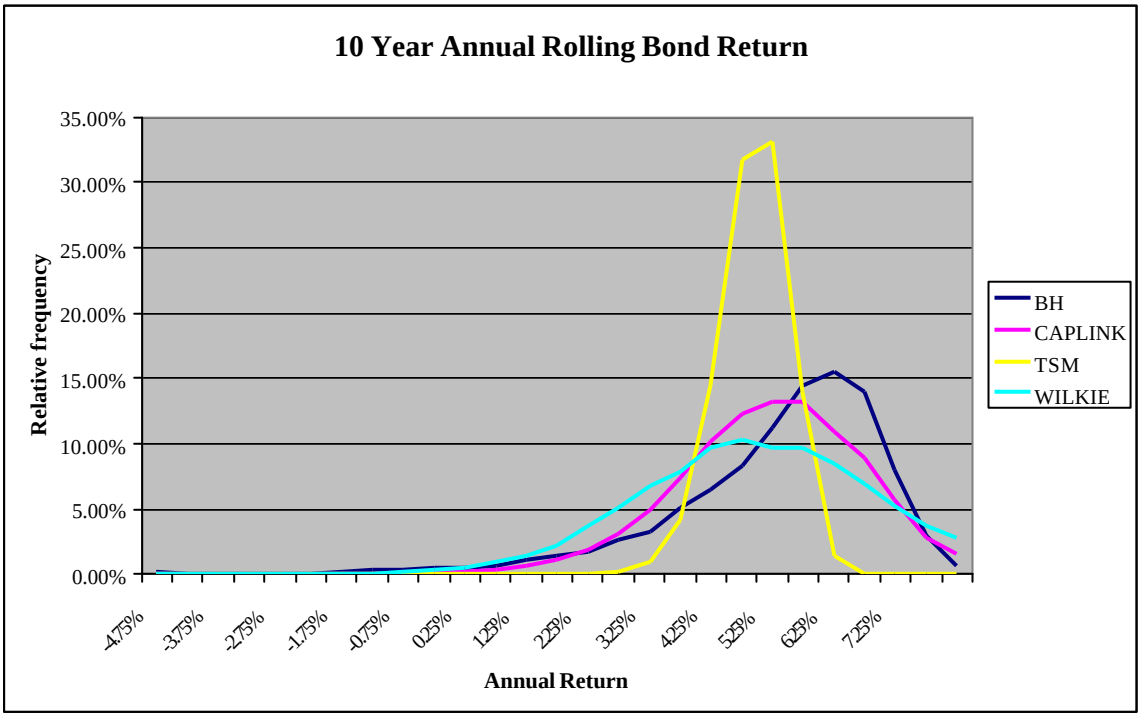
RESULTS

The charts below show the variation between the asset models, which drives the variation in assessed capital needs. Thus although the distributions of 1 year equity returns from all the models are similar, the distributions of annualised 10 year returns are significantly different. Numerical values are given in the Appendix.


1 Year Equity Annual Returns
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Relative frequency
-86.50%
-68.50%
-50.50%
-32.50%
-14.50%
3.50%
21.50%
39.50%
57.50%
75.50%
93.50%
111.50%
129.50%
Annual Return
BH
CAPLINK
TSM
WILKIE


10 Year Equity Annual Returns
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Relative frequency
-15.50%
-9.50%
-3.50%
2.50%
8.50%
14.50%
20.50%
26.50%
32.50%
38.50%
44.50%
50.50%
56.50%
Annual Return
BH
CAPLINK
TSM
WILKIE



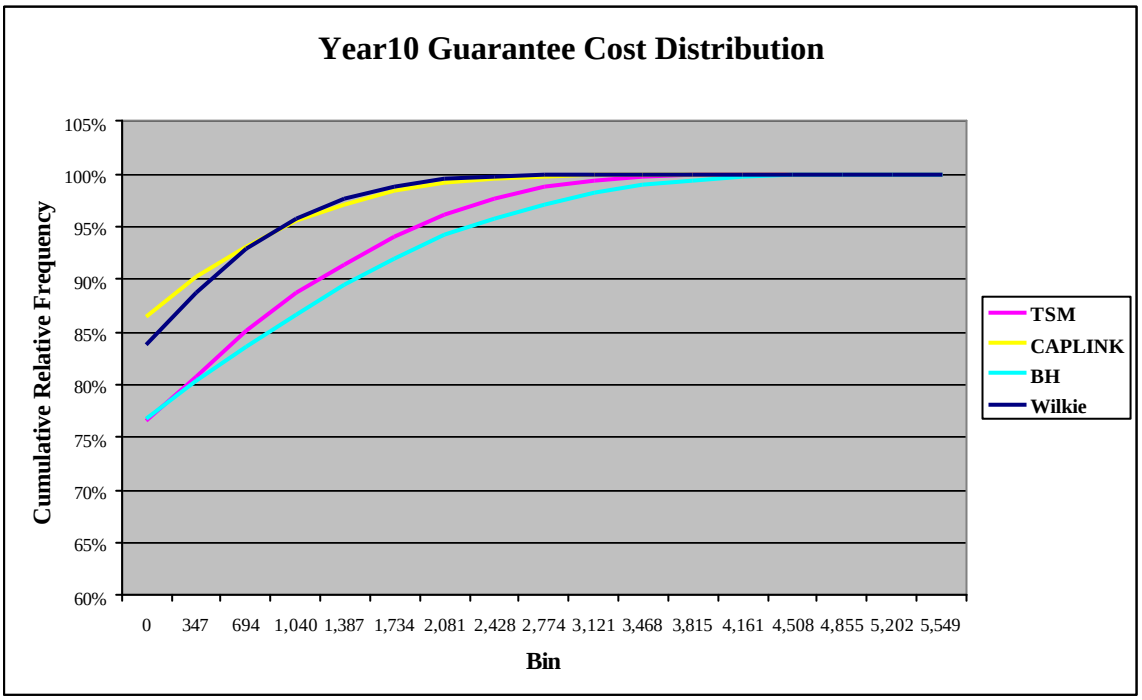


The key results from the model are shown in the table and chart below. It can be seen that the guarantee costs, and hence the capital requirements on the assumption that risks are unhedged, are

significantly different between the different models. Additional results, including sensitivities to different equity backing ratios and bonu sstrategies, are shown in the Appendix.

RUN:	**CENTRAL**
VARIABLE:	**COST OF GUARANTEE**
DISCOUNTED:	**1** (1 = YES, 0 = NO)

KEY STATISTICS	**TSM**	**CAPLINK**	**BH**	**WILKIE**
MEAN	276	118	333	120
STD DEVIATION	651	393	785	357
PERCENTILES				
95.0%	1,877	958	2,245	930
97.5%	2,373	1,502	2,870	1,363
99.0%	2,853	2,019	3,508	1,788
99.5%	3,248	2,338	3,910	2,021
CONDITIONAL EXPECTATION WHERE GUARANTEE COST > 0				
	1,182	865	1,426	736



MODELLING CONCLUSIONS

The modelling did not address the question of the most appropriate time horizon for assessing capital adequacy, due to the lack of an agreed standard for a 'market-consistent' valuation of the year-end liabilities. Nevertheless, even from the simplified modelling work described here a number of important conclusions can be drawn:

- The capital assessment will be heavily dependent on the asset model used;

- Model structure / philosophy and calibration parameters cannot sensibly be separated when deciding whether or not a model is acceptable. Therefore instead of regulators considering whether models have jumps or mean reversion, for example, it makes more sense for them to test empirical output, including reasonableness of fit to historic data;

- The management actions assumed in the modelling are key. Hence it is appropriate for regulators to require some degree of commitment to such actions. In addition, care must be taken to ensure that the effect of these actions makes economic sense and does not simply exploit structural features of the asset model.

INSURANCE RISK

Assessment and management of insurance risk is at the heart of actuarial professional competence. We are or should be aware both of how modelling can aid consideration of capital requirements and of the limitations of our knowledge and techniques in this regard. The literature also includes extensive consideration of the challenges of aggregating insurance risk measures with measures of the other forms of risk to which insurance firms are subjected. For practical reasons there has been some distinct evolution of techniques as between:

- Life assurance, where there has been a relative wealth of fairly homogeneous statistical input data to support detailed modelling of relatively well-defined exposures, although it is recognized that there are real uncertainties as to how the overall trends of underlying experience may evolve in future; and

- General insurance (and reinsurance), which embraces a heterogeneous range of insurance risks more or less amenable to statistical treatment, sometimes with unknown or unstable underlying distributions and subject to significant cyclical influences.

Insurance risk is also usually the dominant risk for firms active in general insurance, but may be relatively less significant for life assurance firms with significant exposures to market risk in particular. At a very high level, the distinction drawn here parallels that between retail and large exposures in banking.

Our purpose here is not to summarise the literature (see the excellent summary by Wason etc for the International Actuarial Association in May 2003) but to allude to some of the principal challenges for the economic capital modeller.

LOW-FREQUENCY EVENTS

Insurance risk significantly embraces a wide range of loss frequencies and severities and it is the quantification of low-frequency high-severity loss events which presents the greatest difficulty, for example:

- The partial or total loss of an insured asset of high or unique value; or

- Loss attributable to a catastrophic occurrence of some natural phenomenon; or

- Loss arising out of a significant threat to public health.

Exposure management is of course a significant requirement, but the challenge remains of using available data and knowledge as best as possible to develop estimated loss frequencies for various events. Extreme value theory is a promising theory, but the move from the observed to the unobserved is full of challenge.

Catastrophe modelling has been greatly refined in recent years, with an emphasis on separate data-intensive modelling of the hazard itself, the vulnerability, the exposure value distribution, and the insurance conditions applicable. These models are a valuable aid to assessment of capital requirements, although considerable uncertainties remain.

DEPENDENCIES

Particularly in general insurance, the potential for subtle interactions of risk drivers is well appreciated – an example is the correlation of various types of claim with economic influences. The nature and significance of such correlations also may change over time.

Tail dependence is the phenomenon whereby certain loss distributions show dependence only in the extreme tail. Using standard correlation analysis can miss the fact that certain areas of the loss distribution are highly correlated, while others are less correlated or independent. Real world examples are numerous – for example Earthquakes causing widespread damage to commercial property and causing Tsunami which leads to Marine losses. Another example is extreme tail correlation of insurance and credit risks caused by major catastrophes leading to reinsurance failure.

Copula techniques are being used to an increasing degree by actuaries and by quantitative analysts in banking to explore the implication of risk interactions.

CYCLICAL INFLUENCES

General insurance underwriting results display significant cyclical patterns, attributed to the low barriers to entry and exit for mobile capital. While firms seek to manage their market share in response to cyclical influences, this works in practice only to a limited degree. The implication is that the expected run-off allowing for contractual risk periods is only a partial picture of the financial resources required to support portfolio outcomes to a stipulated level of confidence.

Economic capital modelling therefore should have regard to the contingencies for evolution of the cycle in order to determine the requirements associated with any particular portfolio position.

CHANGE

A very significant influence on insurer and reinsurer results is change in the context, particularly for longer tail liability and life assurance business. General insurance has been particularly affected by changes (usually adverse) in the legal environment, while in the case of life assurance it has been demographic change, notably increasing longevity, which has caused deterioration of results.

The challenge is to formulate scenarios indicative of the range of future uncertainty, making use of expert opinion from the legal, medical, and other professions as may be required.

STOCHASTIC MODELING OF INSURANCE RISK

We advocate stochastic (probability-based) modelling of insurance risk, supported by consideration of possible scenarios making use of expert input. We believe it is good supervision to encourage the development of relevant techniques, even if it is not yet appropriate to prescribe them, for the following reasons:

- Stochastic modelling is a valuable discipline for risk managers in thinking comprehensively about risk influences and about potential mitigation approaches;

- Stochastic modelling of insurance risk facilitates aggregating measures of this form of risk with measures of other risk sources (market and credit risk) which are necessarily modelled stochastically;

- Stochastic modelling can bring together the concept of fair value – inclusive of 'market value margin' – with required economic capital.

CREDIT RISK

Credit is the major source of risk for most banks and is also a principal source of risk for the majority of life insurers in most developed country jurisdictions. Counterparty risk, especially vis-à-vis reinsurers and intermediaries, may be a significant issue for many general insurers. There is a very extensive literature on modelling and management of credit risk, with some examples included in the bibliography. Our purpose in this section is to describe some of the issues that face actuaries in thinking about modelling in this field, especially in relation to debt instruments.

CHANGING MARKETS

Credit risk shares some similarities with equity risk in that outcomes are linked both to the fortunes of issuers and to market confidence in individual issuers and generally. The issues that present modelling challenges can include:

- Underlying economic change which impacts the real creditworthiness of particular firms and sectors positively or negatively;
- Market views about economic prospects which impact the perceived creditworthiness of particular firms and sectors similarly;
- Cyclical influences which affect actual defaults and market expectations of expected default losses and/or the expected volatility of loss;
- Activities and conclusions of rating agencies which seek to classify debt instruments in terms of creditworthiness as objectively as practicable.

As is the case with equities, credit markets may require the analyst (according to Keynes) not only to judge which of the girls he thinks will win the beauty contest, but which girl he thinks others generally believe will win the contest!

FORM AND SCOPE OF MODELLING

In an ideal world in which assets could be purchased with payments of interest and principal exactly to match certain liability payments, it would suffice to model losses on default based on a combination of historical data and judgement as to how the future might vary from the history.

To the extent, however, that liability payments are uncertain as to timing or amount and that default probabilities and potential losses also are uncertain, it becomes necessary to include in the model changes in the value of debt due to rating transitions and to variations in 'credit spread' - the yield premium required by the market in respect of debt of a given level of creditworthiness.

There is a question here as to the preferred form of economic capital definition, as described earlier in relation to equity risk. If the preferred form is 'period fair VAR' or similar (in preference to confidence of sufficiency over portfolio run-off) then it is of course essential to be able to project the distribution of possible values of debt assets.

HETEROGENEITY AND CHANGE

Very broadly, traditional approaches to bond portfolio credit risk management and modelling have implicitly been as follows:

- Rating agencies have been assumed to be able objectively to assess creditworthiness and to make and review classifications of instruments accordingly;

- Assets could approximately be distinguished between 'high yield' risky debt which displays significant cyclical correlation and 'investment grade' securities where default losses are of a random statistical character;

- The risk associated with investment securities could to a very large degree be managed by appropriate diversification.

Confidence in all of these assumptions is less than it was and the lessons being digested are likely to include:

- It is desirable to have internal capacity to analyses the risks associated with individual borrowers and structures;

- The amplitude of the cycle is not stable and has recently been much wider than would be suggested by relatively recent experience;

- Downside and upside correlations are not the same – in the latest recession there have been significantly correlated downgrades and defaults on what was formerly 'investment grade' debt. Certain sectors – notably telecommunications/technology – featured disproportionately.

OPERATIONAL RISK

WHAT IS OPERATIONAL RISK

The new Basel Capital Accord defines operational risk as the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This definition includes legal risk but excludes strategic and reputational risk.

OPERATIONAL RISK IN BANKING – IMPLICATIONS OF BASEL

Prior to the new Basel Capital Accord banking firms were not required explicitly to calculate or allocate an amount of capital to cover the potential losses arising from operation risk failures. Going forward firms will need to carry out a calculation and allocate a proportion of their regulatory capital to operational risk.

There are three methods outlined under Basel that can be used to calculate the amount of capital required:

- The Basic Indicator Approach;
- The Standardised Approach;
- The Advanced Measurement Approach.

Banks are encouraged to move along the spectrum of approaches as they develop more sophisticated risk measurement systems and approaches but they are expected to use an approach that is appropriate for their risk profiles.

The broad rationale for each of the approaches is that capital is held against the exposure of the institution – in the basic and standardised approaches gross income is used as a proxy for the exposure with the calculation method for deriving the gross income being the differing factor. Under the advanced approach the exposure is based on the risk measurement system that is in place and has been approved by the regulator.

Banks using the Basic Indicator Approach must hold capital for operational risk equal to a fixed percentage (denoted alpha and currently 15% which is set by the Committee, relating the industry wide level of required capital to the industry wide level of the indicator) of average annual gross income over the previous three years.

In the standardised approach the percentage of gross income held to cover operational risk varies by business line – currently from 18% for corporate finance business to 12% for asset management business.

Banks using the standardised and advanced approaches will also be subject to qualitative and quantitative standards. These include:

- Systematically tracking operational risk data including material losses by business line;

- Regular reporting of operational risk exposures to business unit management, senior management and the board of directors;

- Risk assessment systems must be subject to regular external review;

- Risk management processes must be documented well and subject to validation.

PRACTICAL IMPLICATIONS OF BASEL FOR BANKING

The different nature of operational risk compared to, say, market or credit, makes modelling complicated and difficult – the risks are often qualitative and subject to judgement and do not have clear boundaries between the operational risk element and other risk categories such as credit or market. For example, the current trading book market risk capital may include some element of capital for operational risk.

This leads to many problems when trying to analyse data to allow a firm to follow the advanced measurement methodology. There are many potential measurement approaches that can be followed but they usually suffer from drawbacks such as low data quality and large time requirements for analysis. One way around these problems is to use a hybrid approach using scorecards and these methodologies appear to be gaining ground in the industry as they attempt to deal with the implications of Basel.

Collation of data relating to operational risks remains the greatest challenge to the effective calculation of the exposure. The Basel committee carries out data collection exercises, the results of which will be used to contribute to the refinement of the calibration of the basic and standardised approaches and assist in deriving qualifying criteria for advanced approaches. There are however a number of practical drawbacks to data collation and some of these are summarised below:

- Mis-matches may occur between the firm's activities and the Basel Committee's defined business lines;

- Losses may fall into a number of the event type categories with differing views on where the cause lies;

- Lack of data captured from original loss sources may further fog the distinction of cause and type of risk;

- Duplications and omissions, lack of clarity of expected losses may add further confusion.

EXTENDING OPERATIONAL RISK CALCULATIONS TO INSURANCE

Insurance companies are subject to regulatory capital concepts which have similar aims to those applying to banks. It is natural therefore to consider extending the principles applied to banks to insurance companies. However in doing so a further complication arises in determining what constitutes an operational risk loss as there is also the insurance risk angle to consider as well.

POTENTIAL PITFALLS OF APPLYING BANKING OPERATIONAL RISK PRINCIPLES TO INSURANCE

In the basic and standardised methodologies for banks the gross income measure used as a proxy for exposure is defined as net interest income plus net non-interest income. Translating this to insurance

might imply using investment and premium income underlying the various classes of business. However these measures vary in effectiveness as a proxy for operational risk exposure in insurance.

For example, in life insurance, term protection / critical illness and income replacement business might generate lower exposure levels than savings related products but intuitively are as exposed to claims arising from operational risk failures as the other contracts – the nature of the failure just being different. Similar issues can be seen in the P&C market with the various types of protection available.

GENERAL VERSUS LIFE

Operational risk might be said to manifest itself in different forms in life insurance compared to general insurance business. In life business most of the processes are well regulated or heavily automated – the sales methods that gave rise to mis-selling failures in the past are now more closely monitored and regulated and technological advances result in lower system failure occurrences.

Perhaps one area where most operational risk failures in life insurance do occur is unit pricing where manual intervention often overrides automated processes. Here the failures are often small (if detected early) but affect a large number of policyholders, so operational risk failures in life business are perhaps more suitably categorised as high frequency low impact when they do occur.

A similar argument can be made for personal lines P&C business but in the Lloyds and London markets operational risks tend to manifest themselves as low frequency high impact events. The example of an underwriter accepting or pricing business wrongly with high financial impact being potentially an operational risk loss.

OPERATIONAL RISK CAPITAL AS A PERFORMANCE MEASURE

Given the difficulties in calculating exposures for operational risks, categorising claim data and determining distributions, the absolute value of regulatory capital held against operational risk exposures cannot be regarded with perhaps as much certainty as for other risk exposures. As a measure the level of capital cannot be used to judge performance as easily as other capital requirements for other risks. The relative movement in operational risk regulatory capital year on year is a more effective measure of performance over time.

However the overall use of operational risk capital measures is appropriate in the wider context of risk based capital with a Pillar 2 style framework as it is only with both qualitative and quantitative measures that the risk can be measured and managed appropriately.

OPERATIONAL RISK AND ECONOMIC AND REGULATORY CAPITAL

There continues to be some debate about the principle and detail of a capital requirement associated with operational risk, with some critics arguing that this overlaps with the general application of a firm-specific requirement within Pillar 2 and others suggesting that an historically calibrated operational risk capital component (either indicator or model based) may not be an appropriate stimulus for improvement in systems and controls.

The sources of some of these arguments appear to be a little self-serving and even the best-managed banks will acknowledge that they cannot be immune from operational risk. Notably, these banks include some allocation of capital in respect of operational risk within their internal models. Equally, the generality of banks appear to accept that the Basel framework is likely to stimulate risk mitigation over the medium- to long-term.

GAINING SUPERVISOR RECOGNITION FOR INTERNAL MODELS

In this section we trace the evolution of banking supervisory philosophy to the point where internal modelling is an optional advanced approach for all of market risk, credit risk, and operational risk within Pillar 1 subject to certain testing conditions. We trace the much more recent development of insurance supervisory philosophy in a similar direction, and conclude with a view as to why it may be better for economic capital modellers to concentrate on sharing with supervisors within Pillar 2 rather than seeking formal approval within Pillar 1 (at least for quite some time).

BASEL 1 AND TRADING BOOK MARKET RISK

The original 1988 Accord – with Pillar 1 only - did not include any allowance for self-assessment of capital requirements, probably because techniques barely existed in relation to any form of risk and because it was a definite objective to increase bank's capital resources.

Although not included in the original Accord, supervisor review leading to agreement of a firm-specific capital requirement has been a feature of the most developed supervisory regimes in London and New York. Thus supervisors became aware of the widespread practice of attributing capital to trading activities by reference to a value-at-risk measure (originally promoted by J P Morgan / Risk Metrics).

It was decided to amend the Accord to incentivise best risk management practice by allowing banks to base their regulatory capital requirement for market risk in the trading book on their internal models, provided that:

- There needs to be a quantified measure of risk with objective parameters.
- There needs to be independent backtesting to show how the models perform.
- The models need to be integral to the current risk management process.

THE CURRENT PROCESS FOR MODEL VERIFICATION IN BANKING

Credit risk

Internal credit risk models are not currently used to calculate regulatory capital, a crude approach is followed.

Market risk

- Can be calculated using an internal model. No particular guidelines on approach to be used but most banks calculate market risk using VaR (Value at Risk) models.
- The models must satisfy the following criteria:
    - A horizon of 10 trading days
    - A 99% confidence level

- An observation period based on at least a year of historical data updated at least once a quarter

- The regulatory VaR is the multiple of the average of the last 60 days' 1% 10-day VaR estimate when netted across the whole firm, or the previous day's VaR, whichever is greater.

- Model backtesting takes place – backtesting 1% 1 day VaR requires 250 days trading data to be used. A multiplier of 3 – 4 is generally applied to the VaR according to how well the model performs. The 3 – 4 factor is arbitrarily determined allowing for operational factors. (The rationale underlying the multiplier is to guard against systemic risk)

- Scenario analysis is usually required by regulators to understand the effect of moving underlying risk factors from their current state. This is also included in Basel 2 but is not formalised.

We understand that only a relatively small number of UK banks are making use of internal model approaches to determine regulatory capital, although these are likely to account for a significant proportion of trading volume. We understand further that banks generally maintain higher capital levels in respect of trading activities than the absolute minimum emerging from the foregoing formula.

KEEPING UP WITH BEST PRACTICE – BASEL 2

The experience of affording the most sophisticated banks the option of basing the trading book market risk capital on their internal approach is seen as a positive one by firms and supervisors alike, and extending this approach so as similarly to reinforce best risk management and economic capital systems across credit and operational risk became one of the objectives of Basel 2. This led to the internal ratings based credit risk capital requirement determination and to the advanced modelling approach for operational risk capital requirements that are described in CP3. We note that US supervisors intend to make these approaches mandatory for the 10 largest banks operating internationally.

At the same time, it has always been intended that Basel 2 should reflect best supervisor practice by moving to the three-pillar approach, adding supervisor review and market disclosure to the risk-sensitive quantitative minima of Pillar 1. For the most sophisticated banks operating economic capital approaches, we are aware that these are a principal focus of supervisory review, with Pillar 1 compliance treated as being of relatively less significance.

There is a potential disconnect or ambiguity here, in that Basel incorporates a quite elaborate Pillar 1 which may prove quite rigid, while at the same time encouraging banks continuously to develop the sophistication of their approaches within Pillar 2. A possible explanation is that supervisors in different jurisdictions place a different relative emphasis on the pillars – there is some concern that most jurisdictions lack the supervisory strength to make Pillar 2 work as intended.

We would however like to believe that development will be encouraged within Pillar 2, with occasional changes to Pillar 1 almost as a public indicator of best practice to which banks generally may hope to aspire. Indeed it is clear that it will be a considerable effort for banks to implement systems and accumulate data so as to meet the most advanced Pillar 1 approaches, although at time of writing it appears that most players of significance will try to do so.

BANKING AND INSURANCE – A CONTRAST

Our impression is that insurers are, perhaps with the exception of some reinsurers and bancassurers, much less advanced than the leading banks in adopting economic capital management as an integral part of their management processes.

We have seen economic capital techniques in active use in support of:

- Some pricing activities;
- Reinsurance programme management
- Corporate strategic planning and capital allocation
- Asset-liability management

But usually in a partial manner which is in even the largest groups much less pervasive than in the leading banks and would not meet the criteria for recognition within Pillar 1. Part of the reason for this may be that (for reasons described elsewhere in this paper) economic capital for insurance business is necessarily as much dependent on assumptions about the longer-term future as on analysis of historic data. It remains to be seen whether or how techniques will evolve – with supervisory encouragement as described below – over the next few years.

MODEL VALIDATION FOR INSURANCE COMPANIES

While the banking industry perhaps has greater experience in the approval and use of internal models for quantifying market risk within the trading book, there has been little evidence of progress towards an aggregate internal risk model such as is sought by the insurance industry. Even under the Basel II approach, which is over three years from adoption, credit, market and operational risks are assessed separately and then aggregated in setting the capital requirement. Further, market risks are frequently assessed by considering risk factors, such as equity market returns and the level of the yield curve, separately.

The complex interaction governing the relationship between the performance of the company and the payouts under with-profits contracts is perhaps a primary driver behind the quest for an aggregate model on the part of UK actuaries. It may however also be that actuaries are more sensitive to complex risk interactions, particularly in general insurance where integrated modelling approaches such as dynamic financial analysis are furthest advanced.

There is some evidence that the largest European insurers have made significant progress towards developing and using internal risk models, although the 2002 European Commission paper on "Risk models of insurance companies or groups" indicated that only a very small number of the groups surveyed were in a position to use their models in practice.

EXAMPLES OF SUPERVISORY INTEREST

In July 2002, the Australian supervisor (APRA) introduced the possibility for general insurance companies to set their own minimum capital requirements based on the calculations of the internal model. The criteria which the internal model and insurer would need to satisfy for approval are set out in a remarkably straightforward eight page guidance note GGN110. It is perhaps instructive of the difficulties that lie ahead that, to date, no insurer has applied to use its own internal model.

The APRA guidance note is quoted both in the European Commission report and the IAA risk based capital solvency structure working party draft report in outlining possible requirements for validating internal risk models. Many of the points outlined are also reflected in less detail in the Dutch pensioen & verzekeringskamer white paper on the solvency test financial assessment framework and in the paper on the 'Basic principles for the use of internal risk models in insurance companies for the improvement of financial supervision' submitted by German Insurance Association as part of the Solvency II review.

Additionally, in March 2002 the Office of the Superintendent of Financial Institutions in Canada published an instruction guide for companies wishing to use internal models for determining required capital for segregated fund risks. This instruction guide sets out validation criteria that are very similar to those issued by APRA. OSFI also sets out transitional arrangements for any company moving to an internal model based approach whereby the required capital for the first year of use will be 50% of the capital requirement determined by the internal model and 50% of the capital requirement under the standard approach. 100% of the capital determined by the internal model is used from the second year.

MODEL APPROVAL CRITERIA

In all instances where internal models are discussed, the regulatory authority's approval is required before the internal model may be used to set the level of required capital.

The broad criteria that must be met are that:

- The internal model operates within an environment that is robust and supported by adequate resources.
- The model is based on specified risk factors and is calibrated to identify the capital required to ensure a maximum specified probability of default over a particular time horizon.
- The model addresses all risks to which the explorer is exposed to the complexity of the modelling commensurate to the magnitude of the risk.
- The model should be embedded into the day-to-day risk management process of the insurer and the insurer's Board and senior management should be actively involved in the risk control process.
- The model is independently reviewed on a regular basis (possibly by the internal audit function).
- The insurer should have an independent risk management unit that is responsible for the design and implementation of the model and is independent of the insurer's general business units.
- Stress tests must be identified to supplement capital measurement calculations and should be incorporated into model validation procedures.
- The documentation for the model must provide a detailed outline of the underlying theory, assumptions and mathematical basis.

- Significant changes to the model or assumptions or products sold require further approval from the regulator.

Partial models are generally permitted, but there is no opportunity for the insurer to revert to a standard approach once a risk model has been approved unless the regulator agrees in advance.

Overall regulators appear to prefer to issue guidance that allows insurers significant flexibility in the development of their internal models and permits the regulators substantial discretion in model approach. This is likely to lead to a diversity of modelling approaches and prove insupportable by a resource constrained regulator. One way of addressing this problem may be for the regulators to share industry best practice and in doing so, normalise the approach.

The commentary produced above has focused exclusively on the validation of risk models. As can be seen from the results produced in the previous section, the structure and calibration of the model used to produce the realistic balance sheet can also have a significant influence on the reported results. To date, there has been little evidence of detailed quantitative standards being set out for internal capital models. However, the Canadian Institute of Actuaries Task Force on segregated fund guarantees did produce a report addressing, among other things, the issue of suitable investment return models. While the Task Force did not support mandating specific models for establishing investment return paths, they did feel that it was necessary to provide some guidance as to model calibration in order to reduce the range of practice in setting investment assumptions. This guidance took the form of standards for the mean one year equity return, a minimum standard deviation assumption and maximum equity returns at the 2.5th, 5th and 10th percentiles over 1, 5 and 10 years. It appears likely that a similar approach will be followed by the NAIC as an option for companies to meet the C-3 market risk requirement in respect of guaranteed benefits on variable annuities.

The Stochastic Accreditation Working Party was set up by the UK Actuarial Profession as part of the 2005 Accounting Project to consider the issue of model validation for the purpose of calculating fair value liabilities and risk based capital requirements. The Working Party's conclusions are not yet finalised, but initial discussions appear to favour the publication by the Faculty and Institute of Actuaries of guidelines for asset model structure and calibration. A Stochastic Accreditation Board was considered, but was felt to suffer many potential problems such as long lead times for approval, difficulty in staffing with appropriately qualified resources and the possibility that the requirement for formal approval might stifle model development.

CONCLUSIONS – PILLAR 1 AND PILLAR 2

In conclusion, the RBC Working Party would support the approaches outlined above and recommend that any Pillar 1 solvency regime based on capital assessments produced by internal models should set:

- Wide-ranging qualitative standards to ensure the reliability of the model and its integration within the business; and

- Limited minimum quantitative standards to ensure comparability of results across the industry, but incentivise model development.

We are however not particularly confident that it will be appropriate to specify internal model criteria on any wide scale within Pillar 1 immediately (with the possible exception of, for example, equity-linked guarantees). We believe it may be better for both firms and supervisors that economic capital modelling be encouraged within Pillar 2, so that the balance between accumulating credible data and making judgements about future scenarios can be developed within that context.

FURTHER RESEARCH

RISK MEASURES

The working party considered illustrating the issues associated with choice of risk measure as described earlier in this paper – we believe there is a range of possibilities embracing various combinations of confidence thresholds and measurement periods. These issues are treated also in the parallel work of the International Actuarial Association working party. It is likely that the actuarial profession could help firms think about the pros and cons of different measures – for example we are aware of one major bancassurer which recently switched from 'one-year VAR' to a 'portfolio run-off sufficiency' approach.

CREDIT RISK

The difficulties of projecting ultimate losses from actual and potential credit exposures seem likely to continue to challenge risk managers. This is particularly so as the range of securities available continues to expand to include a variety of collateralised or synthetic instruments in addition to more conventional secured or unsecured debt. It also seems likely that corporations will continue to diversify their sources of finance particularly by using a broader range of capital market instruments.

The challenge for researchers is to distinguish between more and less useful modelling approaches, both in terms of the underlying conceptual framework and in terms of the data used. Likely themes will include:

- How best to blend internal and 'consensus' credit evaluations?
- How to distinguish between information and noise from the markets in relation to bonds generally and in relation to specific securities?

INSURANCE RISK

This is core territory for actuaries and is already the subject of significant global research effort, including sharing in increasing degree with other disciplines. Some of the challenges which suggest themselves include:

- Improving the distinction between (random) volatility and uncertainty (as to the nature or stability of an underlying distribution);
- Deepening the statistical development underlying the approach to extreme events;
- Understanding better significant non-stationary influences such as climate change and public health.

LIQUIDITY RISK

As matters stand, liquidity risk is generally less significant than other risk sources dealt with in our paper for most UK insurance firms. History suggests however that as some drivers of risk are 'tamed', others grow in relative importance, and there are examples in other jurisdictions of failures attributable to deficiencies in management of liquidity. We can envisage scenarios in which insurers

originate liabilities which are more volatile backed by asset classes which are less liquid than is the case today.

The direction of research may well be to adapt from the banking sector literature and from lessons learned in other jurisdictions risk management approaches, including models of exposures and of approaches to mitigation.

RISK INTERACTIONS

This paper has decomposed the underlying sources of risk for sake of organizing the analysis, and such a 'bottom-up' approach is required in order to conceive of a comprehensive and credible risk and capital management architecture. On the other hand, risk is not in practice unambiguously classifiable, and the interaction of risk drivers in the environment in which we operate is constantly changing. A trite example is the substantial increase in potential director and officer indemnity claims as a result of litigation stimulated by the falls in asset markets. Equally it is difficult to say whether the Equitable crisis is attributable to market risk, operational risk, or legal risk.

There should be ongoing scope for research on risk sources and consequences both from a 'bottom-up' and a 'top-down' perspective with the objective of continuously developing our sensitivity to potential risks. Risk is a natural concomitant of competitive markets, and our understanding will never quite be complete.

EFFECTIVENESS OF SUPERVISION

In the same way as the Basel process is stimulating dynamic improvement in banking supervision, the move to a more sophisticated Pillar 2 economic capital approach – even if only for more sophisticated firms – is likely to initiate a path of continuous improvement. Research by actuaries and others can suggest improvements in techniques which more nearly achieve the societal objectives of:

- High public and customer confidence;
- Fair and active competition; and
- Stabilisation of financial conditions and markets.

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EQUITY 1 YR RETURN

	BH	CAPLINK	TSM	WILKIE
MEAN	0.084	0.092	0.085	0.084
VARIANCE	0.037	0.031	0.036	0.032
VOLATILITY	0.188	0.167	0.172	0.164
SKEWNESS	-0.081	0.092	0.585	0.492
KURTOSIS	0.266	0.052	0.623	0.466
MIN	-0.568	-0.500	-0.439	-0.430
MAX	0.968	0.944	0.943	1.170
RANGE	1.536	1.444	1.381	1.600
PERCENTILES				
1.0%	-0.379	-0.309	-0.281	-0.270
2.5%	-0.314	-0.245	-0.237	-0.220
5.0%	-0.248	-0.194	-0.194	-0.180
10.0%	-0.175	-0.131	-0.140	-0.130
25.0%	-0.039	-0.029	-0.048	-0.040
50.0%	0.093	0.088	0.066	0.070
75.0%	0.210	0.210	0.199	0.190
90.0%	0.321	0.317	0.329	0.320
95.0%	0.383	0.384	0.422	0.410
97.5%	0.447	0.447	0.509	0.480
99.0%	0.533	0.516	0.610	0.560

EQUITY 10 YR ANNUAL RETURN

	BH	CAPLINK	TSM	WILKIE
MEAN	0.077	0.080	0.079	0.070
VARIANCE	0.004	0.002	0.004	0.001
VOLATILITY	0.062	0.040	0.055	0.033
SKEWNESS	-0.107	-0.016	0.181	0.141
KURTOSIS	-0.034	0.004	-0.042	0.057
MIN	-0.163	-0.088	-0.120	-0.060
MAX	0.320	0.242	0.340	0.204
RANGE	0.483	0.331	0.460	0.264
PERCENTILES				
1.0%	-0.082	-0.020	-0.050	-0.009
2.5%	-0.056	-0.004	-0.032	0.002
5.0%	-0.034	0.009	-0.016	0.013
10.0%	-0.009	0.023	0.004	0.025
25.0%	0.033	0.050	0.037	0.045
50.0%	0.078	0.080	0.077	0.069
75.0%	0.123	0.109	0.119	0.093
90.0%	0.161	0.135	0.157	0.116
95.0%	0.183	0.150	0.181	0.130
97.5%	0.202	0.165	0.202	0.143
99.0%	0.224	0.181	0.224	0.158

RETURN ON A 10 YEAR BOND IN YEAR 1

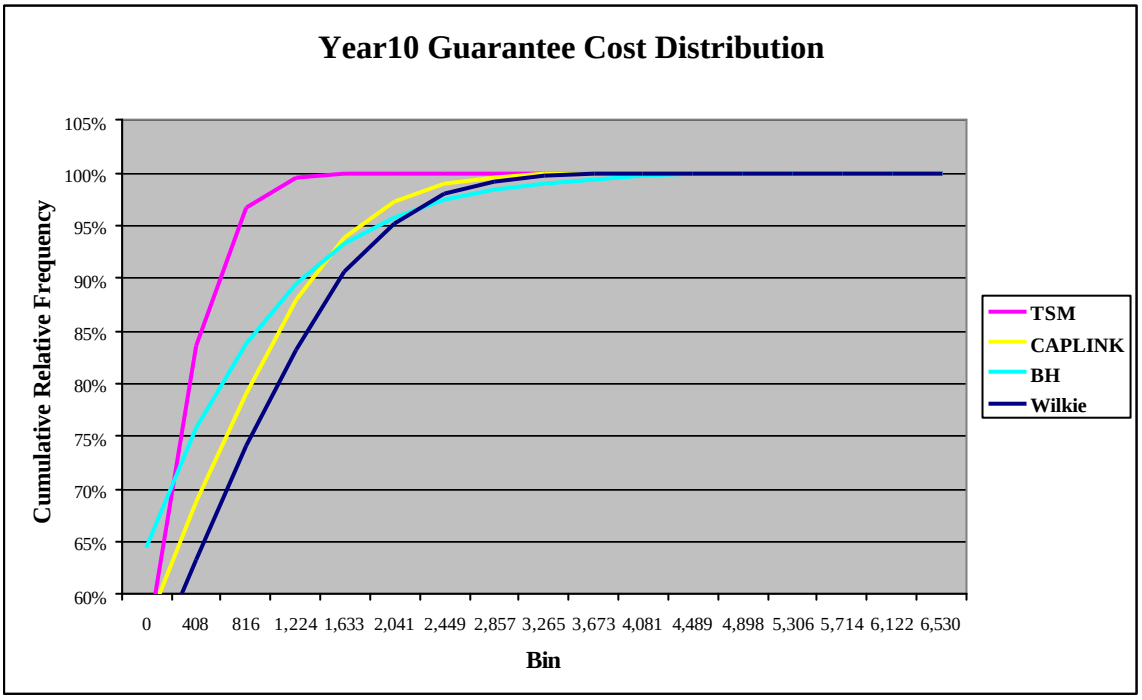
	BH	CAPLINK	TSM	WILKIE
MEAN	0.043	0.043	0.038	0.047
VARIANCE	0.005	0.009	0.001	0.010
VOLATILITY	0.070	0.091	0.035	0.095
SKEWNESS	- 0.252	- 0.018	- 0.161	0.064
KURTOSIS	0.057	- 0.060	- 0.027	- 0.030
MIN	- 0.276	- 0.288	- 0.102	- 0.353
MAX	0.280	0.371	0.163	0.442
RANGE	0.556	0.659	0.264	0.795
PERCENTILES				
1.0%	- 0.137	- 0.178	- 0.049	- 0.175
2.5%	- 0.108	- 0.142	- 0.036	- 0.142
5.0%	- 0.082	- 0.112	- 0.023	- 0.114
10.0%	- 0.052	- 0.078	- 0.008	- 0.080
25.0%	- 0.005	- 0.021	0.014	- 0.020
50.0%	0.046	0.043	0.039	0.046
75.0%	0.093	0.107	0.063	0.113
90.0%	0.132	0.163	0.083	0.174
95.0%	0.156	0.196	0.094	0.211
97.5%	0.175	0.225	0.104	0.243
99.0%	0.196	0.263	0.116	0.280

ANNUAL RETURN ON A 10 YEAR ROLLING BOND

	BH	CAPLINK	TSM	WILKIE
MEAN	0.048	0.047	0.044	0.046
VARIANCE	0.000	0.000	0.000	0.000
VOLATILITY	0.018	0.015	0.005	0.019
SKEWNESS	- 1.898	- 0.331	- 0.442	0.073
KURTOSIS	6.999	0.452	0.425	0.275
MIN	- 0.137	- 0.020	0.018	- 0.028
MAX	0.084	0.103	0.062	0.158
RANGE	0.221	0.123	0.045	0.187
PERCENTILES				
1.0%	- 0.018	0.007	0.030	- 0.001
2.5%	0.000	0.015	0.033	0.007
5.0%	0.013	0.021	0.035	0.014
10.0%	0.025	0.028	0.037	0.021
25.0%	0.040	0.038	0.041	0.032
50.0%	0.052	0.048	0.045	0.045
75.0%	0.060	0.058	0.048	0.059
90.0%	0.066	0.066	0.051	0.071
95.0%	0.069	0.071	0.053	0.079
97.5%	0.072	0.075	0.054	0.086
99.0%	0.074	0.081	0.056	0.092

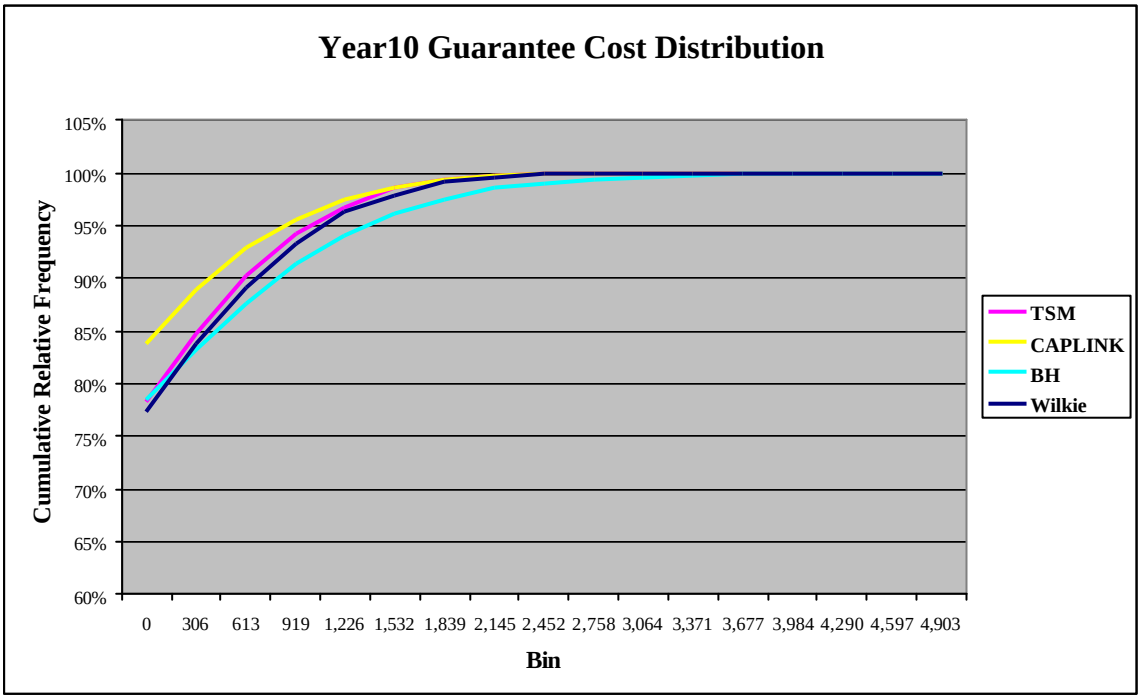
RUN:	**SENSITIVITY1**
VARIABLE:	**COST OF GUARANTEE**
DISCOUNTED:	**1** (1 = YES, 0 = NO)

KEY STATISTICS	**TSM**	**CAPLINK**	**BH**	**WILKIE**
MEAN	162	388	347	487
STD DEVIATION	256	621	707	710
PERCENTILES				
95.0%	725	1,727	1,903	2,004
97.5%	867	2,075	2,494	2,327
99.0%	1,034	2,467	3,254	2,714
99.5%	1,154	2,787	3,748	2,960
CONDITIONAL EXPECTATION WHERE GUARANTEE COST > 0				
	359	899	977	1,016



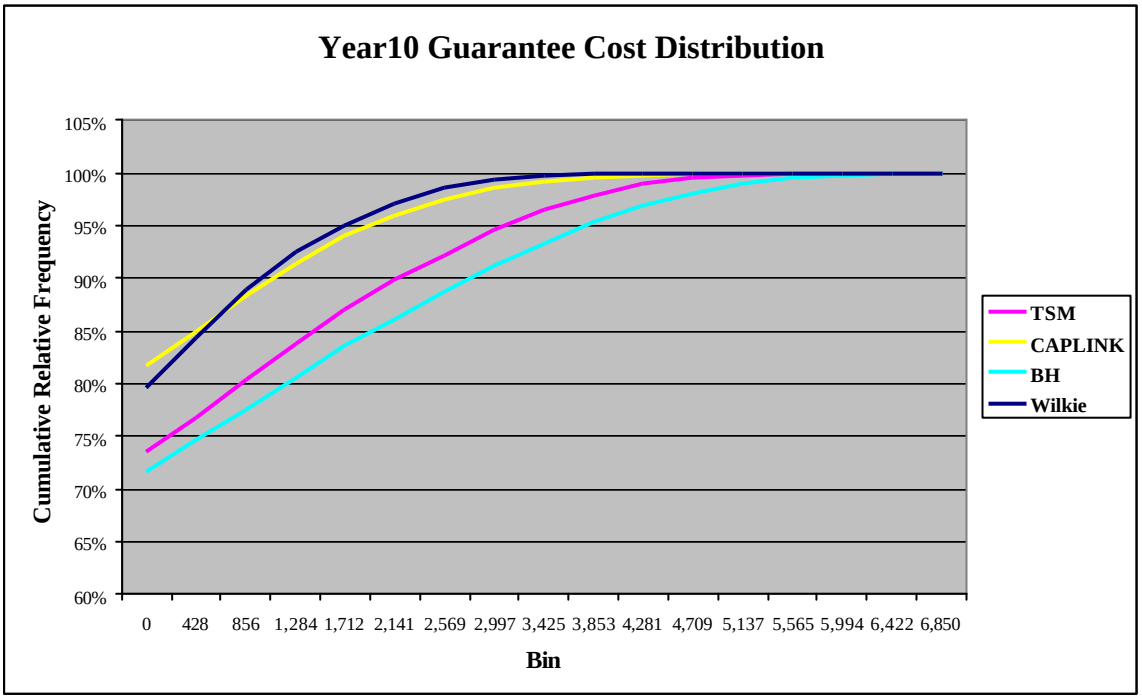
RUN:	**SENSITIVITY2**
VARIABLE:	**COST OF GUARANTEE**
DISCOUNTED:	**1** (1 = YES, 0 = NO)

KEY STATISTICS	**TSM**	**CAPLINK**	**BH**	**WILKIE**
MEAN	143	108	197	159
STD DEVIATION	359	331	507	391
PERCENTILES				
95.0%	995	844	1,359	1,081
97.5%	1,321	1,223	1,824	1,434
99.0%	1,641	1,702	2,419	1,804
99.5%	1,863	2,022	2,831	2,043
CONDITIONAL EXPECTATION WHERE GUARANTEE COST > 0				
	658	670	914	702



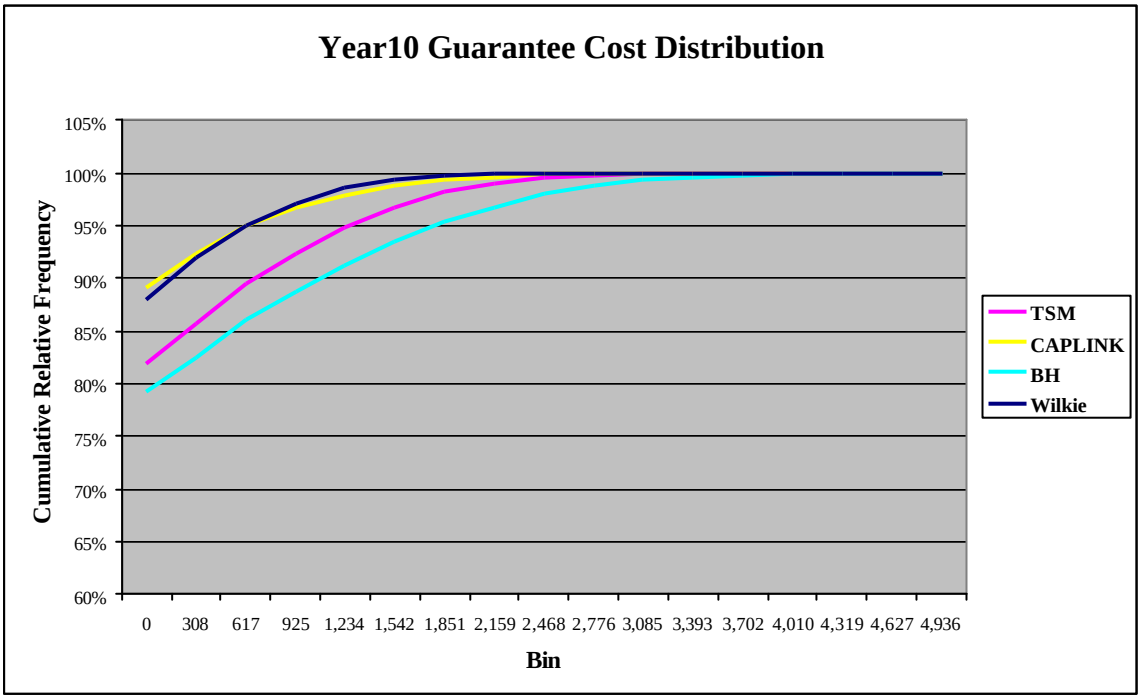
RUN:	**SENSITIVITY3**
VARIABLE:	**COST OF GUARANTEE**
DISCOUNTED:	**1** (1 = YES, 0 = NO)

KEY STATISTICS	**TSM**	**CAPLINK**	**BH**	**WILKIE**
MEAN	495	254	640	231
STD DEVIATION	1,046	688	1,288	598
PERCENTILES				
95.0%	3,069	1,887	3,777	1,666
97.5%	3,701	2,553	4,507	2,253
99.0%	4,319	3,259	5,159	2,792
99.5%	4,656	3,757	5,523	3,134
CONDITIONAL EXPECTATION WHERE GUARANTEE COST > 0				
	1,865	1,392	2,256	1,132



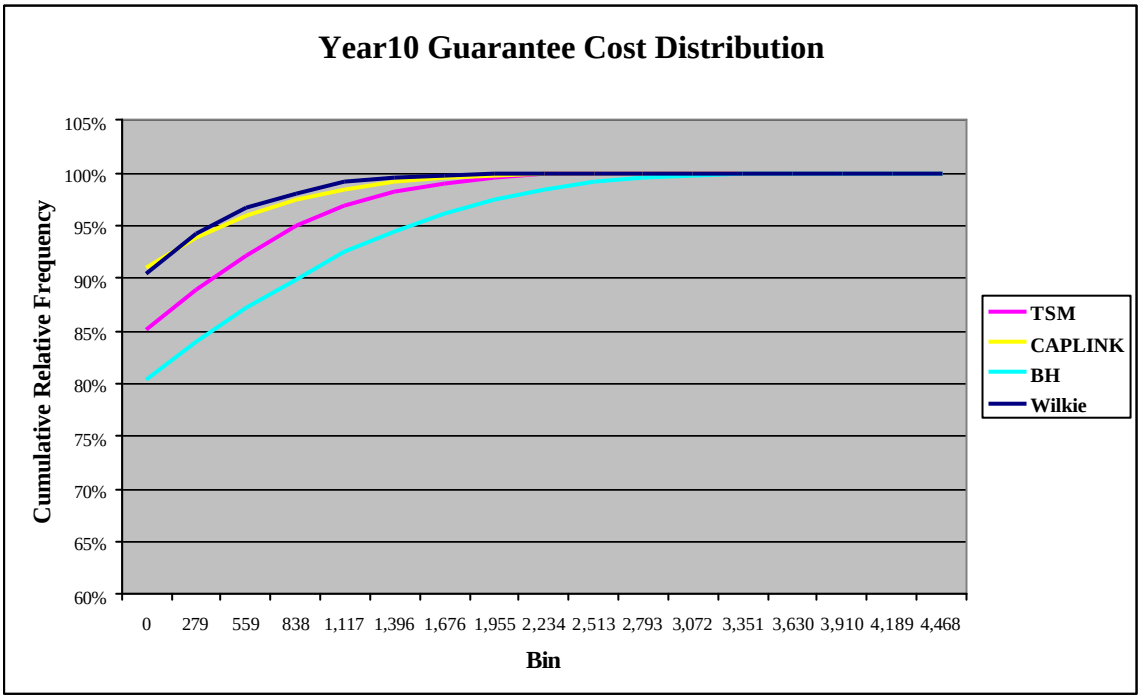
RUN:	**SENSITIVITY4**
VARIABLE:	**COST OF GUARANTEE**
DISCOUNTED:	**1** (1 = YES, 0 = NO)

KEY STATISTICS	**TSM**	**CAPLINK**	**BH**	**WILKIE**
MEAN	164	79	249	74
STD DEVIATION	450	301	629	263
PERCENTILES				
95.0%	1,248	618	1,771	614
97.5%	1,706	1,114	2,318	973
99.0%	2,133	1,637	2,867	1,375
99.5%	2,431	1,967	3,241	1,682
CONDITIONAL EXPECTATION WHERE GUARANTEE COST > 0				
	902	727	1,200	611



RUN:	**SENSITIVITY5**
VARIABLE:	**COST OF GUARANTEE**
DISCOUNTED:	**1** (1 = YES, 0 = NO)

KEY STATISTICS	**TSM**	**CAPLINK**	**BH**	**WILKIE**
MEAN	105	55	199	47
STD DEVIATION	323	236	524	195
PERCENTILES				
95.0%	832	417	1,476	373
97.5%	1,229	851	1,974	702
99.0%	1,659	1,323	2,420	1,074
99.5%	1,880	1,597	2,783	1,317
CONDITIONAL EXPECTATION WHERE GUARANTEE COST > 0				
	701	622	1,010	494



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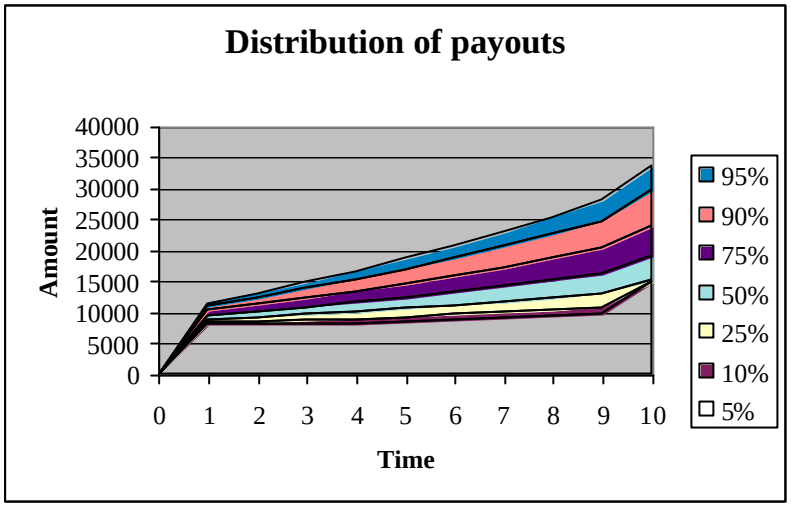
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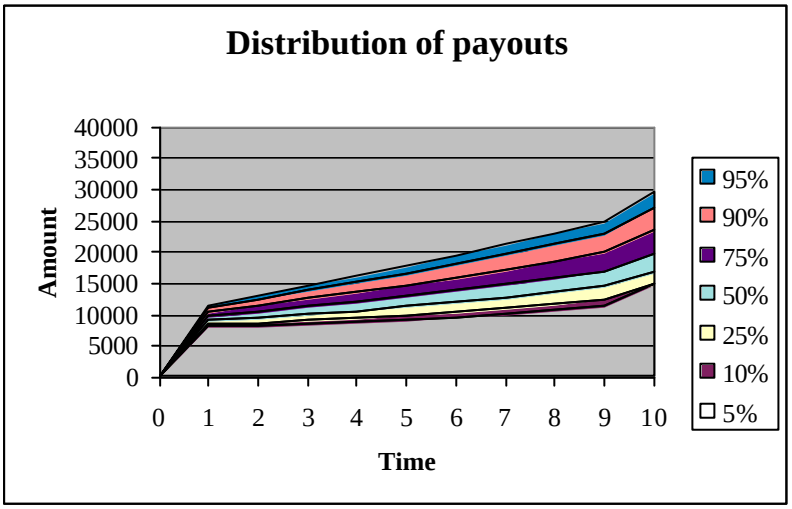
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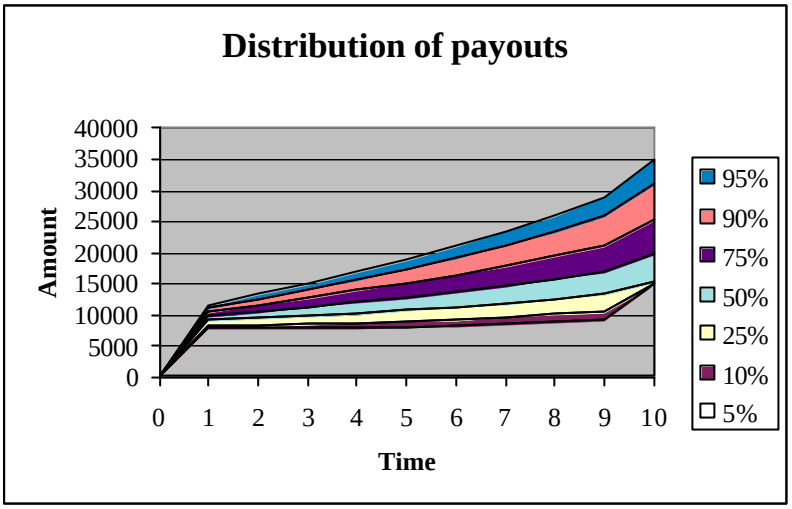
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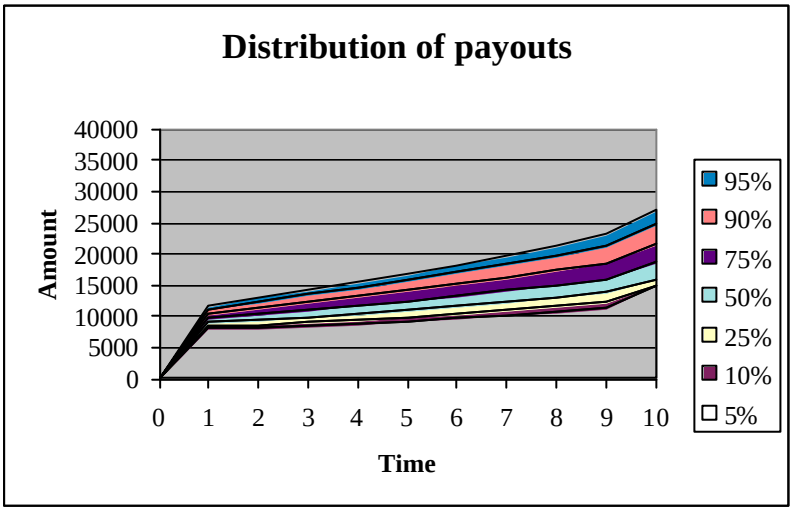
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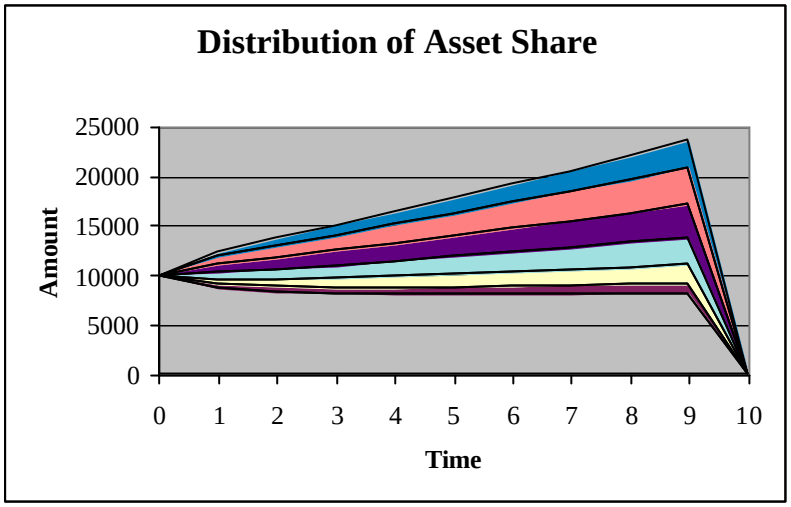
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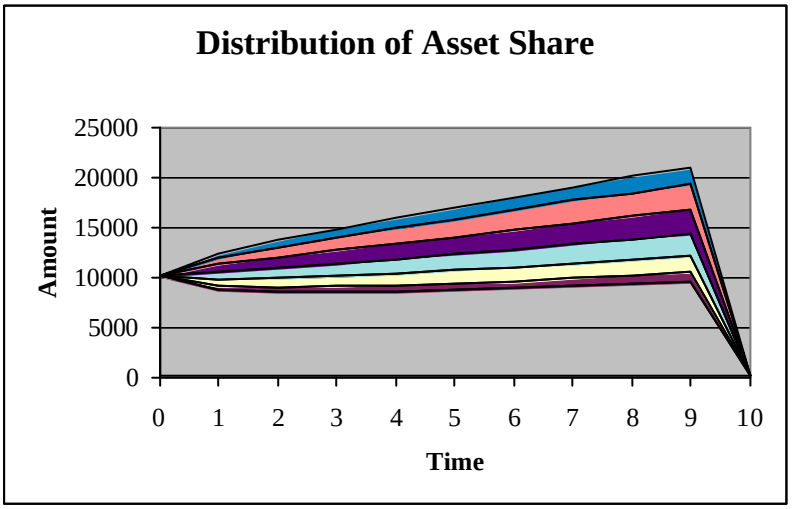
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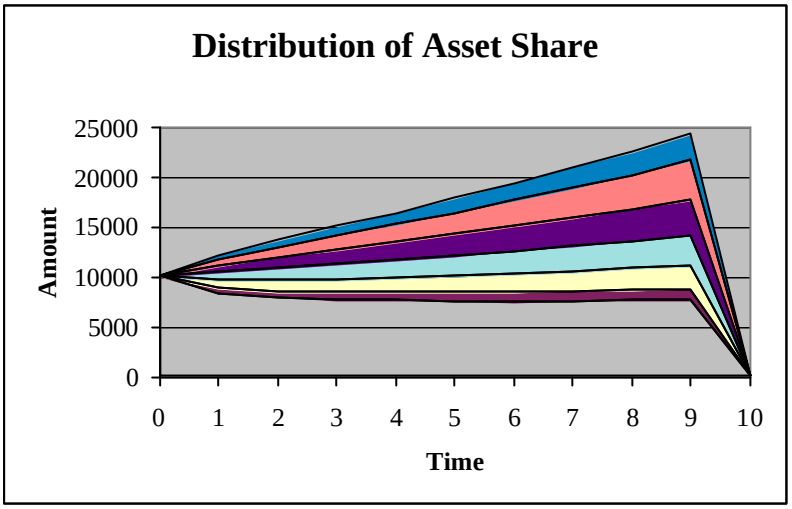
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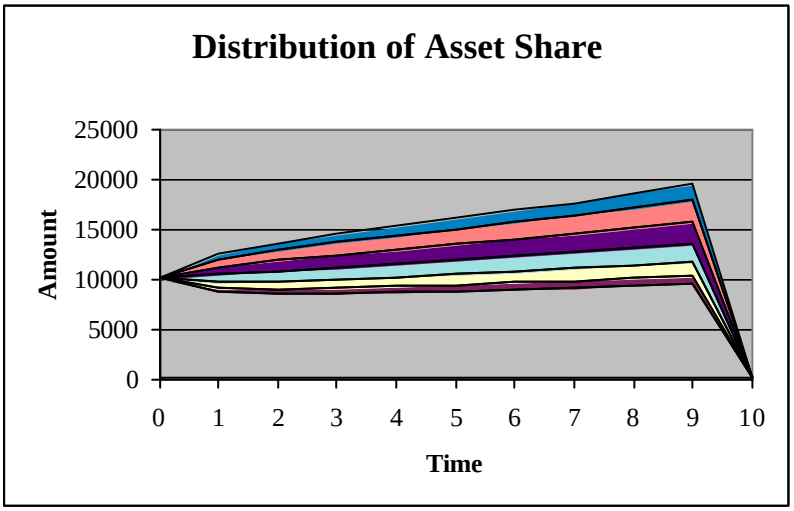
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