

LIFE ASSURANCE RISKS

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Article 328 of the insurance code, which lists out the main classes of insurance, defines life assurance as; “insurance that depends on the human life span”. This is a purely legal but somehow brief definition, which needs to be expanded in order to reflect the full implications of the actual nature of operations.

In the 18th century, Etienne Clavière, founder of the first French Life assurance company and author of the celebrated « 1788 Prospectus » explained the purpose of life assurance in these terms:

“life assurance means a contract by which insurers receive a certain amount annually, over a limited number of years or once and for all, with the condition to pay, on the death of one or several people stated in the contract, a fixed sum or annuity per head for the same one or several persons indicated in the contract. Also included in the insurance contract is the insurer’s commitment to pay the insured a certain amount or annuity, when he attains a certain age till his death.”

Two centuries later, Messrs. Picard and Besson, in their Non-Marine Treaty, define life assurance more simply as:

“the contract through which in consideration of premium, an insurer undertakes to pay the policyholder or a designated third party, a specified capital sum or annuity in the event of the death of the insured person or if he lives up to a determined period” (Picard and Besson, “Non-Marine Insurance, Volume I, Insurance Contracts”, LGDJ, 1982).

Today, this definition seems too narrow considering the volume of group policies companies write.

Thus far, insurance companies seem to establish the object of life assurance as individual or group contracts by which, in return for premiums or contributions,



the insurer undertakes to pay the policyholder or a designated third party, a lump sum or annuity fixed at a certain time and for a duration stated in the contract, in the event of the insured’s death or if the latter lives on.

Given the rather long duration, an average of about ten years, between the time when the insurer collects premiums and when he must fulfil his obligations, he can be exposed to a number of risks, which may compromise

his solvency.

Definition

By risk, the author means any contingency which reduces the insurer’s ability to meet his liabilities.

The issue is to handle not just the contractual liabilities but also other hidden liabilities vis-à-vis shareholders, for instance, in the case of a listed company or contributors in the case of an endowment fund.

For instance, in this last case, protecting annuities against inflation risks constitutes an implied liability for the institution even though this is not necessarily expressed in the contract. Moreover, it is not a case of precise indexation, but rather protection of purchasing power in the long term.

Observation

The risk can emanate from aggravated cost of contractual liabilities (inadequate assessment of loss experience). It can also result from a drop in value, returns, or the liquidity of the insurer’s investment portfolio. Beyond these purely financial aspects, it is equally important to know how risk occurrence will impact on the accounts depending on the requirements of industry specific regulations.

The insurer is confronted with risks from the two professions he is involved in, namely:

- Marketing and management of insurance policies
- Financial management of investment portfolios

The first risk is related to his core business. The insurer manages multiple technical, legal and administrative problems associated with the contractual relationship established with his client or with his partners (distribution network, co-insurers, reinsurers etc).

The second financial risk affects life insurers in particular since the 80s. Indeed, clients, instigated by insurance intermediaries and by the media, always insist on the best returns for their savings and do not hesitate in triggering competition. Therefore, the industry should ensure optimisation of profitability in both finances and risks (i.e. improve the performance of its contracts as well as protect its margins).

The main risks, which weigh on the financial situation of life assurance companies, are listed subsequently. Life annuity risks, which are risks related to the duration of human life, are presented first. Cash-valued insurance products induce financial risks that are different from products in which the covers are denominated in units of account. Moreover, life assurance contracts include hidden options, that is, risks which do not appear on the balance sheet.

Life Annuity Risks

Definition

Life annuity risks are related to the duration of human life. It appears right from the moment the life contract provides for different benefits or different payment dates depending on if the insured lives or dies.

The value of life annuity liability is measured with a mortality table. In fact, this is the age by age, mortality rate of a given population (national population or the insured lives in the society). Once the mortality estimate has been determined, the insurer's risk takes on a dual nature:

- A drop in mortality: With time, policyholders live longer (due to medical advancements, improved living conditions) in such a way as was not envisaged by the mortality table used;
- Anti-selection phenomenon: Policyholders do not represent the populations on the basis of which the death or survival rates were estimated.

However, it is appropriate to note that annuity risks do not exist in most life contracts. It is rather the case with endowment covers where the insurer's liability is limited to the accumulated value of the constituted life benefits. In fact, only provident funds and retirement funds covers pose high life annuity risks.

Terminal Benefits Risks

This refers to benefits paid in event of the insured's death. It mainly concerns the payment of a capital sum.

Two risks are identified:

Frequency risk

The first mortality risk that comes to mind is that of loss frequency. The company must use a mortality table that does not underestimate the probability of death while evaluating its liabilities.

Medical selection enables the company to better assess this risk and consequently avoid a high underestimation of the probability of death. This risk can in part be controlled by excluding some sub-standard risks. Exclusion clauses may target people who have had medical surgery.

In the long run, with the option of reinsurance cover, the insurer may be protected against an increase in loss experience. This would limit the risk incurred by the insurer, as part of the risk is transferred to a specialised company: the reinsurer.

Concentration risk

The second type of risk that could be encountered is the concentration of insured risks. It could happen that an insurer covers death risks of employees of the same company, who may be on the same plane.

In this case, the insurer does not have the actual contractual means of reducing such risks except to limit the covers, which the forces of competition may not allow him to do.

On the other hand, an adequate reinsurance cover may ensure that the risk is shared between several insurance and reinsurance companies.

Pension risks

In retirement policies or life annuities, the insurer protects the insured against the "risk" of survival.

Consequently, this type of policy suffers annuity risks when the number of surviving persons is more than what was projected when pricing, i.e. when insured persons do not die as quickly as expected using the mortality table. Thus, there is a drop in mortality.

Drop in mortality

The drop in mortality is tied to the general improvement in living conditions. In the 20th century it has resulted in a high increase in life expectancy.

In order to take cognizance of and even forestall this trend, insurers have to use specific mortality tables known as prospective life tables (e.g. TPRV93, cf. Chapter 2 appendices) to price and constitute reserves for annuities. Unfortunately, this table does not exist in the CIMA zone. Insurers are still pricing annuities for life risks based on CIMA TV code.

Anti-selection

Moreover, the drop in mortality can be explained through the anti-selection phenomenon.

Definition

Anti-selection occurs when the insurance conditions, price or marketing method ends up making the policy more attractive to clients with sub-standard risks and less attractive to clients with low or average risks.

This phenomenon can also be observed in life annuity policies where beneficiaries averagely live longer than the rest of the population. Life policies do not only contribute to the insured's good health, but because the insured persons knowing their poor health (therefore constituting a low risk... for the insurer) are not interested in tying down capital in a life policy.

Financial Risks

The notion of financial risks cannot be reduced to just volatility of financial results.

In reality, the actual benchmark in financial management is constituted by the insurer's liabilities. The financial risks discussed subsequently are those that can create an adverse disparity between the value of assets and that of liabilities.

The financial risks incurred by the insurer differ depending on the type of liabilities: cash-valued policies or units of account. The two categories of contracts

are redefined below.

Definition

Cash-valued policies are characterised by the fact that the cover is expressed in monetary terms.

For the insurer, this cover always means liability in terms of financial yields for the client (if not a 0% return liability!).

Definition

A units of accounts policy is a cover expressed in given units of account (shares, bonds, OPCVM etc...)

In other words, the insurer, in return for premiums, guarantees a given number of securities without any commitment on the final value of these securities.

Policies in FCFA

The financial risks on currency-based policies can be classified into three categories:

- Exchange rate risk which has to do with the respective currency fluctuations;
- Solvency risk or credit risk, which have to do with a deterioration in the issuer's solvency; and
- Interest rate risk.

Exchange rate risk

This risk arises when the assets are expressed in one currency while the liabilities are expressed in another. Exchange rate risk does not present an actual cost value in insurance in that the insurer is required by regulation to make his investments in the currency of the contract (or in the unit of account which is used to index the contract).

However, in France, some flexibility has made such a risk possible. In effect, some insurance companies can cover their liabilities with up to 20% of their "incongruent" assets. In other words, the insurer can retain his assets in a currency other than that of the liabilities accepted from policyholders provided that they are not more than 20% of the value of the liabilities. The CIMA insurance code does not contain this provision.

Solvency risk

This risk relates to the solvency of the bond issuer as well as the market perception of this solvency.

Indeed, financial players will not wait for a payment default much less a declaration of bankruptcy before interpreting stock prices as a deterioration in the issuer's capacity to pay back his debts.

In addition to the perceived risk attached to a particular issuer, the market can generally adopt a different attitude towards private issuers; in that case, the difference between the interest rate on Government bonds and the rates of private bonds widens (this can be termed "spread risk").

In order to limit such risks, regulations impose a number of investment constraints, which include:

- Spreading the investment amongst different issuers;
- Selecting values based on their legal nature and according to the type of market where they are negotiated.

The legal limit of 5 % per issuer, in principle, allows insurers a minimal diversification of investments. A stricter limit is applied to unlisted securities and further strengthens that legal provision.

For instance, in France, most insurance companies have introduced internal rules for selecting instruments and fixing appropriate limits for bond issuers in a way as to enhance the financial security attached to investment transactions.

Interest rate risks

These are risks related to the interest rate fluctuations on the money market. They can be analysed by breaking them into two categories:

Reinvestment (or rates cut) risk

Definition

Reinvestment risk occurs when the returns on which future investments are based are lower than the guaranteed returns on insurance contracts.

This risk materialises when there is a drop in interest rate, reduced returns on investment, the more so as assets are "shorter" than liabilities;

In other words, when a bond matures, the insurance company proceeds to reinvest the reimbursed nominal value. However, in the case of a reduction in rates, the company will not find investments as profitable as

the previous one (flat risk). In some cases, a negative balance may occur between the rate of investment return and the interest rate guaranteed to policyholders. This differential will reduce quickly moreover as the average tenor of the investment is shorter than the liability period.

Example

Reinvestment risk can be illustrated using for instance an 8-year life policy at a rate on line of 3%, on the basis of which the insured paid CFA 10,000; which to simplify issues, excludes administrative charges. At subscription, the interest rates stood at 3.5 % and the insurer invested the premium in 4-year "zéro-coupons" (a "zéro-coupons" is a type of bond in which the interests are not paid periodically but capitalised and included in the value of the final capital sum). With supposedly stable rates during the first four years, the value of the insurer's investment increases more than that of his liabilities. At the end of 4 years, the "zéro-coupons" are redeemed and the interest rate then drops to 2%. The insurer invests the redeemed value in "zéro-coupons" for another 4 years. During the last 4 years of the policy, the growth value of the insurer's investment is no longer sufficient to meet his liabilities.

In addition, the risk is more tangible as nothing in the law prohibits ownership of an investment portfolio with a much lesser maturity period than the liability period ("short-tail" assets management).

However, interest rate risks are moderated through the interplay of some financial reserves such as profit-sharing reserves (the proportion of financial income, which belongs to the insureds and retained under non-personal headings). These reserves ensure a stability of the financial yields of the contracts, within the limits of established reserves.

Liquidation (or rates increase) risk

Definition

Liquidation risks arise when the bonds are liquidated before they mature, even though the bonds have depreciated compared to when they were bought.

If the insured liabilities expire before the bonds are redeemed, then the bonds must be liquidated. If the interest rates rise, the bonds bought previously have depreciated.

Liquidation risk results from rather “long” assets compared to liabilities. It becomes tangible where interest rates rise as a result of depreciation.

Liquidation risks can arise as policyholders are allowed to sell bonds prematurely. Based on this scenario, the insurance company may end up buying bonds which depreciate more or less in proportion to increase in interest rates (deductions made from the reserves constituted precisely for depreciation of securities may eventually compensate the capital loss). Unfortunately, the phenomenon of increased premature liquidation coincides with increase in interest rates, as it is more profitable in such a context.

Example

Liquidation risk can be illustrated using the instance of an 8-year life policy at a guaranteed rate of 3% on the basis of which the insured pays FCFA 10,000. At inception, interest rates stood at 3.5 % and the insurer invests the premium in 15-year “zéro-coupons”. Interest rates rise to 4.5% sharply after acquiring the “zéro-coupons”. The return on the insurer’s investment is higher than the guaranteed rate given to the insured, however, 8 years later, he would have to bear the depreciated securities due to increase in interest rate. The insurer can no longer meet his liabilities.

Where is the safe middle?

As we have just seen, a life insurance company’s profitability logically depends on the gap that exists between the cost of its funds (determined by its pricing policy) and the profitability of its financial investments. Interest rate risk can be controlled by comparing the duration and yields of liabilities and assets.

From the preceding paragraphs, the reader would have understood that securities should preferably be managed in such a way as to ensure that they are liquidated at the time when the policyholders’ liabilities expire.

Thus far, it has been demonstrated that where the client opts for premature liquidation, there is really no reliable way to measure the duration of obligations against liabilities.

Other options available to clients such as additional premiums, interrupting fixed payments or extending

the existing contract only further complicate envisaged maturity dates.

It should be noted that when liabilities are very long (as the case with some annuity funds that exceed 15 years on the average), it is practically impossible to create and efficiently manage a securities portfolio of equal duration.

Policies in units of account (UC)

Policies in units of accounts are indexed on the market value of one (or several) asset(s), which are units of account. These are generally SICAV, commonly invested funds or shares in real estate companies. There are also policies known as “multisupports” where the client can spread his investment between different assets, which sometimes include cash-valued policies.

The basic principle supporting the financial logic of a unit of account denominated policy is that of an asset rated according to market value and a liability whose growth is wholly tied to that of the asset in question. On that basis, the market risk associated with the increase in the cost of funds is mainly borne by policyholders.

Despite this initial observation, the insurer still has to confront occasionally high risks associated with:

- Regulations, which allow the policyholder the right to cancel his policy a month after subscription (Article 65 of the CIMA code),
- The illiquidity of certain investments such as real estate, which have been accepted as units of accounts,
- The imbalance between assets and liabilities, which may result from a disparity between the date in which the unit of account was purchased and the effective date of the policy or an operational error; and
- Some covers with minimum repayment value (termed “floor”).

Cancellation risk

Policyholders are allowed by regulations to cancel their policy within 30 consecutive days.

For certain policies, that time limit may run indefinitely due to the inadequacy of contractual information provided to the policyholder at the inception of

contract.

Generally, it should be noted that a normal units of account depreciation risk occurs within the 30 days, whereas the client can cancel his policy and have his premiums reimbursed.

In order to protect themselves against such risks, insurers generally arrange for such funds to be temporarily invested in a monetary fund, which is unaffected by the market fluctuation risks.

Illiquidity risk

The insurer cannot disengage himself from his liabilities by handing over the units of account to the insured. He must pay the euro equivalent of the securities (except if the insured explicitly requests payment through units of account).

For the insurer, illiquidity risk means his inability to sell off the unit of account when the policy matures. This risk can materialise during a financial crises period as the case for the real estate market in the early 90s. Such a risk can have its full implications where policies tied to such units of accounts are redeemed prematurely.

One of the rare counter-actions is for the insurer to acquire the units of accounts for himself using his shareholders' funds or the equivalent contract value in euro.

It goes without saying that a company where the balance sheet reflects a high proportion of illiquid units of account-based policies and which in addition has a foreign currency funds, might run into great difficulties.

Asset-liability imbalance risk

This risk is evident when the asset composition for the policies in units of account does not accurately match the insurer's units of account denominated liabilities.

The risk occurs when the insurer does not buy (or sell) on time, the outstanding number of assets, which emerge from the differences in liabilities in units of account.

A simple example

A policyholder pays a premium of FCFA 10,000. The payment is converted into units of account. However, when posting the purchase details into the computer, an

error is committed on the number of units to be acquired.

A more detailed example

General insurance conditions specify a value date, i.e. the date (for instance Monday at the opening of market) in which the payments (for the previous week for instance) are converted into "nombre ducs". However, the insurer must send in his purchase or sales order before this date (Friday by 12.00noon for instance). In addition, he must prepare his orders based on estimated price as at the value date. As a result, there is always a disparity between orders placed and those that are supposed to have been placed.

This imbalance between assets and liabilities expressed in units of account may have the following implications:

- Exposure to bearish markets in the event of over-insurance, i.e. when the number of assets representing the liabilities in units of account is higher than the number of liabilities taken by the insurer;
- Exposure to bullish markets in the event of under-insurance, i.e. when the number of assets representing liabilities in units of account is lower than the number of actual liabilities taken by the insurer;

Minimum benefits risks

In general, such covers guarantee the repayment of a minimum sum in the event of death, but also sometimes in the event of survival.

The insurer is exposed to an amount equal to the positive difference between the lowest value and the acquired value, which in itself is determined by market trends.

Here, the problem arises from the combination of two independent risks, the one relating to the human life span and the other to the financial markets environment.

Although the first case is easier to understand statistically, it is not the same for the second, moreover as the usual financial methods used are inconsistent with the long term conditions which generally prevail in Life assurance.

However, it should be noted that most of the time,

insurers include certain protective measures in the contract such as:

- Maximum age beyond which the cover cannot be granted;
- Limits on terms of benefits;
- Limits on the period of cover
- Limits on choice and type of units of account.

It should be noted that in the case of Life covers, based on the given deadline, minimum benefits can prove to be financially burdensome for the insurer, unlike death risk covers, because after this deadline, it only depends on the insured's goodwill. The policyholder will naturally claim his reimbursement whenever it serves his interests best, which in this particular instance are quite contrary to those of the insurer.

As it will be seen, there are other cases where the clients' options may be used to the detriment of the insurer.

HIDDEN OPTIONS

An overview of hidden options

The hidden options are not secret neither are they deliberately concealed from the different stakeholders (policyholder, insurer, auditors).

Definition

Hidden options are guarantees or privileges granted by the law to policyholders by way of contractual clauses and intended to make the policy more flexible and attractive; there are no distinct reserves in the insurer's accounts for these options.

Although these covers can in some instances constitute a significant expense for insurers, they are not ordinarily included in identified accounting provisions and therefore perfectly deserve to be called "hidden options".

Often, they occur depending on the policyholder's decision (they should really be called "insurance contracts options"); to that end, these options are a contingency.

Observations

Hidden options also include insurance contracts that are comparable to normal financial options (sales, purchase or exchange of securities, minimum or maximum rates,

minimum guaranteed rates, indexation options etc), within the context of Life assurance, these options sometimes occur due to uncertain non-financial circumstances.

The hidden options make it difficult to assess the financial risks incurred by the insurers. Indeed, they are numerous and very difficult to assess. Furthermore, they are rarely standardised and based on the contract design adopted by the insurer, can either be totally harmless or very dangerous in certain instances.

Here is a list of possible (inexhaustible) options in an endowment policy:

- **Cancellation:** This is the legal option given to clients enabling them cancel their contract and recover their investment one month after subscription.
- **Cash surrender value:** This buyback option allows clients to use all or part of their available savings (generally mathematical reserves) before the normal expiry of contract and in most cases, at any time without any penalty on the insured.
- **Transfers, arbitrages:** The arbitration option is granted to clients within the context of multi-supported units of account to enable them modify through their insurer the asset composition used to index their contracts. These changes sometimes attract costs and the amounts or duration can be limited.
- **Extension:** When the contract expires, the covers can be renewed for another year or several years. The extension can be automatic or on client's request.
- **Reinvestment and/or upfront payment of guaranteed interest rates:** This has to do with the opportunity given to policyholders to pay additional premium during the course of the contract. The rates applied to such premiums can be the ones specified from the beginning of the contract or the ones obtainable as at time of payment.
- **Paid-up:** This is the option whereby clients can cancel payment of future premium for contracts which provide for periodic premium, but a reduced

sum assured becomes payable on maturity or earlier death.

- **Loans:** Such loans are granted to clients who apply within the limits of a portion (80%) of their savings with an insurance company. The loans are subject to professional recommendations under the form of ethical codes regarding the rates of returns and duration.
- **Conversion into annuity:** When the policy expires, the client has the option of converting all or part of his capital into annuity. This means using the accumulated capital to buy an annuity. The annuity is calculated based on rates (mortality table and technical rates) predetermined at the inception or otherwise, fixed when the policy expires.

The following covers are independent of the clients' decisions, but are born out of the same problems as the preceding options (contingency, lack of accounting provisions on expiry).

- **Minimum guaranteed rates:** This indicates the minimum annual returns on cash-valued policies.
- **Hedge effect:** Hedging allows the client, in the same way as guaranteed interest rates, to enjoy a minimum rate below which the value of his constituted savings cannot drop irrespective of subsequent market developments.
- **Floor value:** This is the minimum repayment or buyback value indicated in some units of account-denominated policies.

THE INSURER'S OPTIONS!

For cash-based policies, the insurer's contractual liabilities generally determine the profit-sharing rates. On the other hand, the insurer reserves the right to select placements (within rather flexible regulatory limits).

Therefore, the insurer's first option is the free choice of financial policy, which however directly influences the policyholders' future participation in profit-sharing. For instance, the insurer may prefer fixed income investments, or otherwise, seek to increase his capital gain, which enables him "manage" the performance of his contracts.

In addition to this determining factor, the insurer also

possesses "hidden options". These options have value and in terms of complexity are no different from those of the insured:

- By opting for capital gains on investments, the insurer can partially control the return on his assets;
- Depending on the circumstances, he may decide on reserves or recover from capital reserves by selling depreciated or appreciated securities;
- The insurer may defer or accelerate profit-sharing by making use of profit-sharing reserves;
- And then, except where there is strict control, the insurer is allowed to spread profits over different policies.

It can therefore be observed that if there is a natural connection between the financial results of the insurer's capital and the profit-sharing rates given to policyholders, then the connection is far from straightforward.

This has been a description of the main risks facing a Life Assurance company. These risks, which compromise both the technical and financial balance of Life insurance results, should be specially managed using the actuarial management tools of the balance sheet. Therein lie all that is needed for asset-liability management.

In practice, the expression "Asset Liability Management" (ALM), which is used by bankers, has become a household term. Even modern regulations use the terms "asset" and "liability" simultaneously:

This represents a set of forecasting methods, risk analysis tools, and management techniques intended to control all manners of financial risks. Consequently, Asset-Liability Management connotes:

- A permanent assessment procedure for the above-mentioned risks
- A decision process which will enable the insurer confront these risks

In order to clarify the subject, several definitions of Asset-Liability Management have been given in this paragraph.

Asset-Liability analysis is first of all a management

tool to draw up financial, technical and marketing policies. Furthermore, Asset-Liability Management first of all concerns mainly economic and financial issues, as it adds prospective meaning to solvency by adds prospective meaning to solvency. To that end, an Asset-Liability Management Committee should exist, terms of reference drafted and an active, independent supervisory unit established.

Definition

In its broader sense, asset-liability approach involves assessing every management decision within the framework of the active harmonisation of the balance sheet.

This definition is too general to be useful (almost every management decision will have an impact on the balance sheet), however, its advantage is that of emphasising the general characteristics of the asset-liability method.

Definition

In a narrower sense, asset-liability management involves studying and controlling financial events.

The financial events in question are significant movements in economic indices or market rates and actions. Asset-liability management is concerned with the accounting and financial implications of these events.

This second definition implies that priority should be given to financial strategy issues, i.e. strategic asset allocation issues. By strategic asset allocation, the author means:

- Distribution of assets between classes;
- Selecting sensitive interest rates products.

This definition equally emphasises risk control and insolvency risks in particular. However, this is not to say that questions cannot be asked on how to optimise the profitability of the insurer's business or how different financial parameters impact on his results.

As asset-liability analysis must also feature in liability management, the second definition remains insufficient for the technical definition of insurance products and interest rate policy used generally.

Moreover, several financial decisions can influence

balance sheet risk significantly and the border line between operations for which the funds manager is solely responsible and those that must pass through the asset-liability analysis test is blurred.

Asset-liability management is a general tool for both technical and financial departments. It contributes to decision-making and risk control, in terms of strategy and sometimes tactics.

It should therefore be expected that asset-liability management will provide information and prospective studies that will help to:

- Define financial policies (asset allocation);
- Define reinsurance policies;
- Define products (covers, rates, innovations);
- Define contract remuneration policies;

In addition to these standard areas, asset-liability analysis can extend to how to optimise both profitability and overall risk for the insurer. A broader analysis is needful and not only in terms of the volatility of financial results. Asset-liability techniques must ensure periodic assessment of balance sheet risks and this assessment can be included in the guidelines for general management.

Also, actuarial literature has produced three generations of tools and a fourth is in the making.

First generation tools

The first generation tools are directly inspired from early banking control tools for interest rate and liquidity risks. They are based on projections and by comparing financial flows of assets and liabilities.

These projections are generally made statically, that is from the asset and liability stock as at a given date, without taking into account production and subsequent investments:

- For liability, actuarial models are used to estimate inflows;
- For assets, financial front and back office tools are used to estimate securities-related inflow.

Cash flows can be compared using a semi-banking perspective; that is, measuring the following for

different maturities:

- Cash flow surpluses or deficits;
- Capital financing cost (for the insurer the average rates used),
- Profitability of working capital (financial assets profitability ratio).

This generation of tools equally include general interest rates assessment concepts, the calculation of actual net values of financial inflows and sensitivity, duration and interest rates immunisation concepts.

Observation

These last methods are very similar to actuarial techniques for calculating the intrinsic value of contract portfolios.

Second generation tools

The second generation tools are balance sheet simulation models. These models allow for the projection of financial and accounting results and balance sheet growth based on a set of detailed scenarios determined by the user.

These sets of scenarios involve economic, financial environments as well as production and clients' behaviour.

The second generation models are known as "deterministic models" or "deterministic scenario models" as opposed to third generation models.

Deterministic asset-liability models can be more or less complete and detailed. Generally, they ensure:

- A forecast of the entire balance sheet using a dynamic approach; that is by taking future production into account;
- A simulation of asset-liability interactions and accounting provisions;
- Testing of different financial policies.

Deterministic models are mainly used to forecast results from a budgetary perspective, and also to test the strength of the balance sheet against adverse financial conditions.

Compared to the first generation, studies do not reveal just "interest rate risk indicator" but a wider range of asset-liability risks.

Third generation tools

Third generation tools are "stochastic models". They use simulation techniques similar to those of deterministic models, but in this case the economic and financial scenarios are no longer directly determined by the user.

The model itself generates a large number of risky scenarios and calculates the results of all the scenarios. The basic principle behind all these selections called "Monte-Carlo method" is to consider the randomly produced scenarios as "equiprobable".

Thereafter, it could be possible to systematically calculate the expected average results, confidence intervals and measure the distribution of results. Different risk indicators, such as the probability of production results falling below a certain threshold, can be obtained.

For these models, there are also several degrees of development, mainly as regards the description of financial scenarios. These random selection methods can vary from the simplest to the most sophisticated.

While waiting for the fourth generation

A fourth generation shall be achieved by defining an objective function for the insurer and by programming optimisation algorithms. These algorithms shall automatically call up asset allocations and "best" rates policies for clients.

This area of research is vast and interesting, but it requires perfect knowledge of 2nd and 3rd generation models. Each generation tool capitalises on the experience gained whilst developing the previous generation.

The optimisation methods can only be profitable if the stochastic financial scenarios used adequately represent middle/long term risks. This is not in any way a trivial problem and still requires serious research efforts from the industry.