THE INVESTMENT RISKS OF INSURANCE ENTITIES

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ABSTRACT

Any investment portfolio involves an element fo risk due to the fact that the rate of return may turn out to be lower than expected. This risk is made up the several components: the risk of illiquidity, insolvency, fluctuation in interest rates on the market, fluctuating exchange rates. The intensity taken on by such risks over the next decade will represent a major challenge for actuaries, who must identify them as completely as possible, quantify them and find ways of either controlling or eliminating them.

The author looks at these problems in the wider context of the management of the portfolio of an insurance entity and as part of the company's global risk policy.

As regards the problem of how to measure corporate risks, the author concentrates solely on exposure to interest rate fluctuations, making use of the idea of duration, and he provides an outline of how financial futures and options can be used for hedging against such risks

1. INTRODUCTION

The economic performance of insurance entities is being determined increasingly by the financial returns on their investments. A large part of investment made by insurance entities is used to cover the Technical Reserves, as a result of which the freedom of investment of an insurance entity's resources is often subject to legal restrictions. Such restrictions are generally aimed at ensuring an adequate balance between the principles of yield, risk and liquidity, bearing in mind that resources need to be available to fulfil aleatory obligations.

Any investment or investment portfolio involves an element of risk due to the fact that the rate of return may turn out to be lower than expected. This risk is made up of several components, the most important of which are:

- The risk of illiquidity.
- The risk of insolvency.
- The risk of fluctuations in interest rates on the market.
- The risk of fluctuations in exchange rates.

Such risks are not new, and one could therefore have reason to believe that this subject si sufficiently well known. However, this is not the case. At the present time, the intensity at which such risks are appearing, the forms they are taking, the transactions with which they are associated, all represent a major challenge for Actuaries, who have the job of identifying them as completely as possible, as well as quantifying them and finding ways of either controlling or eliminating them.

In this talk we shall confine ourselves exclusively to the risk of fluctuations in interest rates on the market. The risk of fluctuations in interest rates is the risk of making losses as a result of changes in the interest rates on the financial markets, either because such changes reduce the financial return on the investments made or because they affect the net worth of the assets in which the investments are made.

Returns on investment are now the main source of profit in insurance entities, or in other words, they represent the possibility of earing an adequate return on equity and also a major of financing increases in the Solvency Margin. The size of financial returns depends, among other variables, to a great extent on the interest rates of the financial markets and on the size and the structure of the investment made. As a result, in any active management of investments, at least three factors must be taken into accout. In particular, an analysis of the characteristics of the risk of changes in interest rates on the markets, their determination and the manner in which they should be managed, becomes essential.

This approach makes it essential:

a) To analyse the economic and financial environment in order to find out what factors are likely to bring about changes in interest rates on the market;

b) To identify and measure the risk of changes in interest rates on the market for the structure of the investment made by an insurance entity;

c) To find out what problems are involved in managing the risk of changes in interest rates on the market, what instruments should be used, what decision need to be taken, etc.

2. THE MANAGEMENT OF THE INVESTMENT PORTFOLIO OF AN INSURANCE ENTITY.

Managing the investment portfolio of an investment entity can be regarded as a process:

- Which commences when a decision is taken as to what financial resources out of available funds may be used for making long-term investment. This probelm and its solution arise because an insurance entity has to be able to use its available resources to meet aleatory obligations. The speaker examined this problem in a paper called: "Determination of the amounts available for long-term investment in an insurance company"(1). Insurance entities must therefore decide what part of their resources should be invested in highly liquid assets, because they are only available for short-term investments, and what part may be used for long-term investments, where the investor is almost entirely concerned with yields and risks. In the view of the speaker, the solution to this problem must be found on the basis of the cost of the illiquidity. This means that the problem of illiquidity must be looked at in terms of the cost of illiquidity.

- When investing the resources available for long-term investment, one should begin by determing:

a) The acceptable level of risk, taking all its components into account, and in particular, the risk of changes in interest rates on the market;

b) The anticipated return.

Life insurance entities must also take into account the fact that the anticipated net return on their investments must be higher than the technical interest rate they use in calculating premiums and mathematical reserves.

Another fundamental restriction that needs to be borne in mind is that insurance entities have to cover the minimum solvency margin in order to be able to carry on with their operations in the future, as well as any other legal restrictions(2).

The model designed by H. Markowitz for selecting portfolios solves the problem of the composition of portfolio, in accordance with risk

(1)See E. Prieto Perez: "Determination of the amounts available for long term investment in an insurance company". The Geneva papers on risk and insurance. No. 11 1979.

(2)In E.C.E. countries, they are set by the Third Directives of Life Insurance and Non Life Insurance.

preferences and the required levles of returns on investment, subject to the restrictions that we have just mentioned.

Until not so very long ago, there was no way that the management of investments made by insurance entities could be looked at on this scale, because this aspect of insurance business was strictly regulated. Moreover, over the last two decades, a series of revolutions have taken place one after the other in the financial world, affecting financial assets, theory and financial institutions. In the new economic and financial context, policyholders have become demanding and more price-sensitive with regard to insurance products. This has led insurance entities to operate at reduced technical margins and even with technical losses, in any case, at margins that are too low either to provide a sufficient return on equity or to finance the minimum solvency margin. The immediate consequence of this has been an increase in concern about financial management.

H. Markowitz's model provides efficient portfolios[3], i.e. the portfolio has the characteristic that, for a given anticipated return, μ, it has a minimal risk, or it provides the maximum return for a given lovel of risk, σ.

When we refer to a financial asset included in an efficient portfolio of investments, the total risk arising out of the investment in that asset is made up of two components, as described below:

$$\text{Total risk} = \text{Systematic risk} + \text{Non systematic risk.}$$

The systematic risk is that part of the variability of the return on the financial assets that has a common cause. It is normally caused by economic, psychological and political changes that affect all the assets (securities).

The non systematic risk is related to causes and events that can be attributed to the issuer of the financial assets, such as new patents, management errors, strikes, etc.

Efficient portfolios of financial assets only have a systematic risk, also known as volatility. The total risk of a financial asset is not significant if it is going to be part of an efficient portfolio, simply because the

[3] We refer not only to the model designed by H. Markowitz in itself, but also to other models that are based on the same principles, such as the Diagonal Model designed by W. Sharpe, and the simplified model designed by the same author.

unsystematic risk is eliminated as a resul of the diversification that is involved in an efficient portfolio[4].

As a result of this explanations, it can be seen that the risk of fluctuations in interest rates on the market is not eliminated by an efficient diversification, i.e. by using H. Markowitz's principles as a basis for selecting the portfolio of investments. It is therefore essential to take a look at the problems that are involved in managing the risk of fluctuations in interest rates on the market, what instruments should be used, what decisions need to be taken, etc.

It is obviuos that an Insurance Entity nowadays has no choice but to tackle the problem of setting up and managing its investment portfolio rationally. The problem of managing a portfolio is not, however, confined to the selection process. Rather it commences with the selection of the portfolio.

The selection of portfolios makes it necessary to establish expectations that may or may not be confirmed in the course of time. In the course of time, new information becomes available, expectations change and what was originally the best portfolio becomes less than the best when seen in the light of the latest expectations. In short, portfolios nearly always have to be reappraised after a certain period of time. The portfolio needs to be adapted in expectations. Otherwise it will no longer be optimal.

It is essential, when reappraising portfolios, to bear in mind the situation of the financial markets and to estabilsh expectations of trends in interest rates that can be confirmed.

The considerable volatility of interest rates on the financial markets over the last fifteen years has meant that the financial returns of insurance entities have also been very volatile and this is where there is a need to manage the risk of fluctuations in interest rates on the market adequately. It should be borne in mind that in a situation where interest rates are falling, the financial return earned by insurance entities may drop more than expected because the issuers of financial assets will show a greater tendency to make of early redemption or conversion clauses.

It should also be pointed out there is another important factor which gives further strenght to the argument for a more professional management of insurance entities' investments. This is due to the fact that the

[4]See E. Prieto Perez "La diversificación de una cartera de valores". Anales del Instituto de Actuarios Españoles". No. 19, 1978.

deregulation of the financial systems has brought with it a gradual blurring of the frontiers that traditionally existed between different types of financial intermediaries (in particular, Banks and Insurance), as a result of which, altough these frontiers do still, they have become more porous and much less rigid, and that as result financial intermediaries now have to manage thier financial resources optimally, and Banks in particular have created products that complete with the products offered by insurance entities. This competition has resulted in the price of insurance products being reduced to a minimum and, in some cases, down to rates that were insufficient. As a result, as we have already mentioned, the profits of insurance entities now come from virtually only one source: the returns on their investments. This explains the growing interest in the world of insurance in introducing more modern techniques for managing investments and that such techniques are being used more and more widely.

The changes that we have just described have transformed the environment in which insurance entities operate and have made it more turbolent which has affected the stability and the risks of companies. The environment in which insurance entities operate has changed because of new competition, new markets, more demanding customers, and a generally increased uncertainty at a macroeconomic level. Insurance entities are therefore faced with a situation where results are more volatile and the risks of the company are greater. Of course, there are also new opportunities, new financial technology, and the financial markets insurance entities can tap have become more developed and more efficient, and they can use data processing and communications systems to attain higher levels of productivity and obtain information in record time or in real time. Legislation has also become more flexible: 1) Investment legislation now allows for adjustments to be made to investment portfolios in short periods of time, whenever this preves advisable and 2) the easing of legislation on products now allows for the creation of new classes of insurance and services that are becoming more and more complex, and for applying their placement on the market, as "a priori" controls have been abolished and replaced by "a posteriori" controls. based on the Solvency Margin.

3. Measuring the risk of fluctuations in interest rates

After analysing the external and internal circumstances that make it necessary for insurance entities to manage the risk of fluctuations in

exchange rates actively, we must now refer, albeit very briefly, to how such risk are measured and the techniques that are used for managing this risk.

In this regard, it is essential to analyse the sensitivity of the value of a financial asset and of the value of the portfolio of investments to fluctuations in interest rates on the market. Some financial assets are not sensitive to fluctuations in interest rates; others, however, are more less sensitive to such fluctuations. Furthermore, the sensitivity of the portfolio of investments as a whole will be different to the sensitivity of each individual financial asset that it contains. The portfolio of short-term securities, financial variable interest accounts, certificates of deposit, bonds, debentures and shares, are all particulary sensitive to fluctuations in interest rates.

An analysis of the sensitivity of the financial assets and of the portfolio of investments will provide us with a reasonably precise idea of the insurance entity's exposure to the risk of fluctuations in the interest rate on the market.

The company risks of an insurance entity can be managed using different methods. However, all such methods must be rational and fulfil a number of basic principles, which are as follows:

- The position taken by the insurance entity with regard to the risk must be homogeneous. According to this principle, it would not, for instance, make any sense for an insurance entity to have a detailed policy for selecting insurable risks and a reinsurance policy in line with its financial situation and its level of solvency, while at the same time having an investment policy that focuses entirely on the expectation of a return on the investments projects which fails to take into account the level of risk of such projects or where this level of risks bears no connection whatsoever with the levels considered for insuring the risks.

- The management of the investments must be based on a forecast of trends in interest rates prepared by experts and on the adapting of the portfolio in response to trends in these expectations, taking into account the cost of the operation needed to adapt the portfolio.

An insurance entity should therefore be in a position to decide what percentage of investment risk it wishes to take on over a given period of time, so that later, on the basis of its forescasts of general economic trends in the various different sectors, in securities markets and in particular in interest rates, it can decide on a composition of its investment portfolio that is compatible with legal restrictions.

3.1. The concept of duration

A fluctuation in the interest rate on the market affects financial assets in two ways:

a) The fluctuation in the interest rate affects the reinvestment of the monetary flows generated by the financial asset in question and,

b) The fluctuation in the interest rate affects the price of the financial asset on the market.

The theory of financial immunisation was invested as a means of protecting the forecast rate of return of a portfolio of investments from the effects of interest rate fluctuations. The objective of the theory is to design a portfolio of securities in such a way that its value over a certain period of time will remain at least at the level it would have had if the interest rates had not changed at all, provided that the investor pursues an active strategy of reinvesting the flows as soon as they appear.

One of the basic concepts of the theory of financial immunisation is the idea of duration.

In order to make this concept clear, we shall look at the case of a bond which entitles its holder to collect coupons for an amount $I_k (k = 1, 2, \ldots, n)$ and a redemption value of C_n. The interest rate for the period under consideration is i. Under these conditions, the formula for calculating the value of the bond is as follows:

[1] $$V = \sum_{k=1}^{n} \frac{I_k}{(1+i)^k} + \frac{C_n}{(1+i)^n}.$$

The value of V is a function of i. Hence:

$$\frac{dV}{di} = -\left[\left(\sum_{k=1}^{n} \frac{k \cdot I_k}{(1+i)^k}\right) + \frac{C_n \cdot n}{(1+i)^n}\right] \cdot \frac{1}{1+i}.$$

Definition. – *Duration is denominated as:*

[2] $$D = \frac{\sum_{k=1}^{n} \frac{k \cdot I_k}{(1+i)^k} + \frac{n \cdot C_n}{(1+i)^n}}{\sum_{k=1}^{n} \frac{I_k}{(1+i)^k} + \frac{C_n}{(1+i)^k}}$$

3.2. Properties of D

1) From the definition of D it can be deduced that:

$$\frac{dV}{V} = -\frac{D}{(1+i)} \cdot di\,.$$

The coefficient $D^* = D/(1+i)$ is called the sensitivity of the bond under consideration.

2) The unit change in the value of the security dV/V, brought about as a result of a change in the interest rate on the market, di, is equal $D/(1+i)$. In other words, the exposure to a fluctuation in the interest rate in a fixed-interest bond is proportional to its term. Moreover, the sensitivity of the bond, D^*, is equal to the duration divided by the discount factor $v = 1/(1+i)$.

When an interest rate structure is set up on the basis of maturity, the duration should be used a measurement of the maturity period of the asset in question. In other words, it is a measure of the time during which the financial asset is really exposed to the risk of a fluctuation in interest rates. Another interpretation of duration, which is more interesting from the standpoint of financial immunisation, is that the duration is equal to the price elasticity of a financial asset with regard to fluctuations in interest rates.

3) If $\mathcal{C}$ is a portfolio with $N_s (s = 1, 2, \ldots, k)$ units of Financial asset A_s, the value of $\mathcal{C}$ is:

$$V = \sum_{s=1}^{k} N_s \cdot V_s$$

$$\frac{dV}{di} = \sum_{s=1}^{k} N_s \frac{dVs}{di}\,.$$

It can proved that

$$\frac{dV}{V} = -\frac{D}{(1+i)} \cdot di$$

where

[3] $$D = \frac{\sum_{s=1}^{k} N_s \cdot D_s \cdot V_s}{V}$$

where

$$D_s = \text{ Duration of asset } A_s \, (s = 1, 2, \ldots, k) \, .$$

[3] Indicates that the duration of a portfolio of investments is equal to the weighted average of the durations of each component asset.

4) If we have a bond that gives n constant coupons for an amount I and which is redeemed for C'. The formula for calculating its market value at an interest rate i is as follows:

$$\begin{aligned} & V = \sum_{s=1}^{n} \frac{I}{(1+i)^s} + \frac{C'}{(1+i)^n} \iff \\ [4] \qquad & \iff V = I \cdot a_{\overline{n}|i} + \frac{C'}{(1+i)^n} \iff \\ & \iff V = \frac{I}{i} + \left(C' - \frac{I}{i}\right)(1+i)^{-n} \, . \end{aligned}$$

The [4] indicates that a bond with a coupon I during n years, is equivalent financially to a non redeemable bond with a coupon I and a bond with no coupon with a redeemable value in n years' time of $(C' - I/i)$.

It can be deduced from [4] that:

$$\begin{aligned} & \frac{dV}{di} = -\frac{I}{i^2} + \frac{I}{i^2(1+i)^n} - \left(C' - \frac{I}{i}\right)\frac{n}{(1+i)^{n+1}} \iff \\ [5] \qquad & \iff \frac{dV}{di} = -\frac{I}{i^2}\left[1 - \frac{1}{(1+i)^n}\right] + \left(\frac{I}{i} - C'\right)\frac{n}{(1+i)^{n+1}} \, . \end{aligned}$$

By definition we can write:

$$\frac{dV}{V} = -D \cdot di \iff D = -\frac{\frac{dV}{di}}{V}$$

and therefore, [4] e [5] give:

$$[6] \qquad D = \frac{\frac{I}{i^2}\left(1 - \frac{1}{(1+i)^n}\right) + \left(\frac{I}{i} - C'\right)\frac{n}{(1+i)^{n+1}}}{\frac{I}{i} + \left(C' - \frac{I}{i}\right)(1+i)^{-n}} \, .$$

The following special cases can be deduced from [6]:

* Zero coupon bonds. In this case:

$$V = \frac{C'}{(1+i)^n} \quad \frac{dV}{di} = -\frac{n \cdot C'}{(1+i)^{n+1}}$$

$$D^* = \frac{n \cdot (1+i)^{-(n+1)}}{(1+i)^{-n}} = \frac{n}{1+i}$$

$$D = n$$

i.e.. The duration is the same as the maturity.

* Non redeemable bonds. In this case:

$$V = \frac{I}{i} \qquad \frac{dV}{di} = -\frac{I}{i^2}$$

$$D^* = \frac{1}{i} \qquad D = \frac{1+i}{i}.$$

The duration is therefore a function that depends on the maturity of the security, n, on the nominal interest rate of the bond ($i_k = I/C$) and the market rate of interest (i), i.e. $D = D(i_k, n, i)$.

By studying this function we can say that:

* D is an increasing function of n until it reaches a maximum.
* D is an increasing function of i_E and a decreasing function of i.

As a result, for the same fluctuation in the interest rate on the market, di, the change in the value of the bond, dV, will be greater the lower the current market rate and will be even greater if the par value is high.

3.3. Practical implications

On the basis of what we have just said, we can deduce that the duration can be used in two ways:

I) If the interest rates on the market are expected to fall, by attempting to increase the Duration of the portfolio of bonds, the value of the portfolio can be increased to a maximum, and the return will be higher than the capital gains that would be obtained on the basis of the increase in market rates.

If, on the other hand, it is anticipated that the interest rates on the market are going to rise, the aim will be to shorten the Duration of the portfolio, thus hedging it against the capital losses that such a drop in rates would entail.

Of course, once the drop or rise in interest rates has been confirmed, the portfolio should be restructured in order to achieve an efficient portfolio in the new situation.

It is not always possible to anticipate movements in interest rates on the market; in such cases, the duration of a portfolio of bonds provides the level of risk involved in the portfolio.

This analysis obviously an implicit hypothesis, i.e. that the structure of current interest rates moves in parallel. This hypothesis does not always apply and, to the extent that this is the case, the duration will only provide a rough idea of the risk involved in the portfolio.

II) When selecting a portfolio of bonds, one should proceed as follows: First of all, the level of risk of the portfolio of bonds is selected, in relation with the fluctuations in the interest rate and secondly, the optimal portfolio is selected.

4. The use of financial futures and options to hedge against the risk of fluctuations in interest rates on the market

One way of hedging against the risk of fluctuations in interest rates on the market is to act in the futurest or options markets. In effect, in this way the insurance entity transfers all or part of the risk of fluctuation in interest rates to another participant in this market who wishes to hedge against an opposite position.

A number of technical problems arise. 1) As future or options are not available for every single kind of bond, it is necessary to chose the contract best suited for hedging in each particular case. 2) Another important difficulty is the determination of the volume to be hedged or how many contracts should be entered into.

The solutions offered for finding a technical solution to this problem include the methods which make use of the duration of the portfolio. The manager of the portfolio of bonds may express the hedging objective in terms of duration, D^*, which should be the optimal duration in some sense. The number of whatever futures contracts or options contracts are carried out must be such that the duration of the portfolio is reduced to D^*. Anticipated changes in interest rates on the market will be reflected in the determination of D^*.

With this outline of the possibilities available for controlling the risk of fluctuations in interest rates on the market, within the limits that are compatible with the plans and solvency of insurance entities, using

futures or options, we end this paper, in the hope that we will come back to this subject on a subsequent occasion in order to provide a reasoned and rigorous esplanation.