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CONTROLLING THE INTEREST RATE RISK OF A PROPERTY-LIABILITY INSURANCE FIRM

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Article abstract

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ABSTRACT

Deregulation and globalisation have contributed to increase the volatility of financial markets. As a result understanding and controlling the risk arising from changes in interest rates has become a major issue, particularly for financial intermediaries which are considered most exposed to it. In this paper the author addresses the particular case of a property-liability insurance firm. Once basic concepts have been presented, the determinants of the interest rate risk exposure are identified. A discussion follows to analyse the difficulties encountered to control the risk and to present possible risk reducing strategies. The author observes that the necessary conditions for immunisation might be difficult to fulfil, particularly when the goodwill represents a significant part of the firm's economic value of assets. The complexity of the situation and the importance of subjective factors in the determination of the interest rate risk exposure of the insurer's equity value are finally presented in the conclusion as major impediments to more rationality from investors which might well explain a high volatility of insurance stock prices.

RÉSUMÉ

La dérégulation et la globalisation ont contribué à accroître la volatilité des marchés financiers. En conséquence, l'analyse et le contrôle du risque provenant de la variation des taux d'intérêt sont devenus des préoccupations majeures, en particuliers pour les intermédiaires financiers qui sont réputés fortement exposés à cette forme de risque. Dans ce papier, l'auteur s'intéresse au cas particulier d'une compagnie d'assurance de dommages. Une fois présentés les concepts fondamentaux, l'analyse porte sur les déterminants de l'exposition au risque de taux. Une discussion s'engage ensuite; elle met en évidence les difficultés rencontrées pour contrôler ce risque et permet de présenter quelques stratégies de couverture. L'auteur observe que les conditions nécessaires à l'immunisation peuvent s'avérer difficile à satisfaire, notamment si l'achalandage représente une part importante de la valeur économique de l'actif. Dans la conclusion, la complexité de la situation analysée et l'importance des facteurs subjectifs sont enfin présentés comme autant d'obstacles à la rationalité des investisseurs qui pourraient bien expliquer une forte volatilité du prix des titres représentatifs de sociétés d'assurances.

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■ INTRODUCTION

Interest rates have shown a relative stability at a low level in the recent years. However, the fear of accelerating inflation, which would force central banks to rise interest rates, explains why managers remain, nevertheless, most concerned with their influence on the shareholders value. Simultaneously, insurance companies have to adapt to the new environment which results from globalisation and deregulation in the area of financial services. This trend increases the complexity of operating insurance business, and therefore justify and draw the attention that academics pay to this field of study.

The interest rate risk of life insurance companies has been addressed in a number of papers[1], the focus on life insurance being explained by the particularities and the long-term nature of saving type life insurance contracts. Property-liability insurance, on the other hand, has drawn less attention, though, this activity may also generate a severe interest rate risk exposure. In the following we start with a brief presentation of fundamental concepts used for the purpose of interest rate risk analysis. Then, we provide a description of the « economic » balance sheet of the insurance firm which is a necessary step to specify the risk exposure. Finally, we discuss different strategies designed to control the risk.

■ INTEREST RATE RISK : FUNDAMENTAL CONCEPTS

For any particular asset, the magnitude and sign of the influence of interest rate changes depend on the distribution of associated cash-flows over a period of time. Let's consider an asset A providing a periodical income R_t up to horizon T, then, its economic value V is obtained by summing up discounted R_t:

$$V = \sum_{t=1}^{t=T} R_t / (1+r)^t$$

A move in r will determine a change in V, we then have :

$$\partial V / \partial r = -\sum_{t=1}^{t=T} tR_t / (1+r)^{t+1} + \sum_{t=1}^{t=T} \partial R_t / \partial r / (1+r)^t$$

We can also derive the duration formula for A :

$D = \partial V / \partial r \,.\, 1/V$

$$D = -D_m/(1+r) + \sum_{t=1}^{t=T} \partial R_t / \partial r / (1+r)^t / V \qquad (1)$$

Expression (1) is usually referred to, as the « *modified duration* », defined as the percentage change in value of the asset considered due to a change in the discount rate. On the right side of (1) the « *Macaulay duration* », D_m, corresponds to the average time period at the end of which cash-flows are received[2]. The higher this delay is, the highest is the relative sensitivity of V to a change in r. The negative sign indicates that an increase in r will induce a downward movement for V. This is evident since discounted values are reduced when the rate is inflated, and the further the date considered the strongest this negative is influenced. However, would r increase we may expect a compensation if $\partial R_t/\partial r$ is positive, if cash flows are positively correlated with r. Typically, this occurs for variable rate bonds for which the negative impact of an increase in the reference rate is offset by the coupon adjustment.

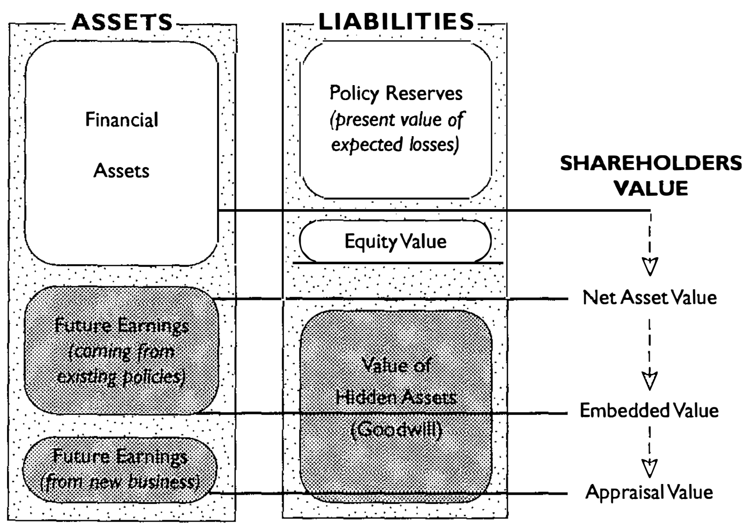
It should be noted that both debtors and creditors are exposed to this type of risk. For instance, holders of a fixed income security would benefit (suffer) from a decrease (increase) in the discount rate whereas, at the same time, issuers of this bond would see the market value of their debt move up (move down). As a result, to appraise the net exposure to interest rate risk of any agent, we need to know the structure of his net wealth (assets minus liabilities) and identify the characteristics of the associated streams of cash inflows and outflows. Coming to the case of an insurance firm, shareholders own the net cash flow pattern generated by this particular business which need to be analysed with great details if their interest rate risk exposure is to be assessed.

DESCRIPTION OF THE INSURANCE FIRM (ECONOMIC) BALANCE SHEET

The shareholders value (K), or net worth, is the difference between total assets (A) and liabilities (L). On the assets side, we have ignored the modest amount of physical capital companies necessary hold to focus on financial elements only. On the liabilities side, ignoring the elements unrelated to outstanding policies, we have policy reserves and equity (figure 1).

Focusing our attention on economic value of equity and its interest rate sensitivity, we cannot refer to book values which may differ significantly from an estimate based on cash flows. Also, we must consider hidden assets which often constitute an important source of equity value, though, they are omitted from the current balance sheet. Hidden assets are related to future earnings that cannot be ignored from those who have invested money in the company, or think of doing so. On figure 1, we have distinguished two components of hidden assets depending on whether expected future income is attached to existing policies likely to be renewed, or to new business which the company can normally expect to develop, considering its position on the insurance market (technical efficiency, distribution network, size, reputation...).

FIGURE 1
SIMPLIFIED BALANCE SHEET FOR A PROPERTY-LIABILITY INSURER



At this stage of the presentation it is important to distinguish different concepts of shareholders value which are commonly referred to in the insurance literature. The *Net Asset Value* (NAV) is the difference between the market value of financial assets (most of which are invested) and the present value of policy reserves. The

Embedded Value (EV) is obtained by adding to NAV the present value of future earnings expected from the renewal of existing policies. Finally, the *Appraisal Value* (AV) includes all elements by adding to EV the present value of future earnings expected from new business. Of course, AV is most relevant in the present context, since it reflects all sources of future cash flows which contribute to equity value. In the following, we will use the term *goodwill* [3] (G) to refer to the total value of hidden assets since both of its components reflect expected value from future business.

SPECIFICATION OF THE INTEREST RATE RISK EXPOSURE OF A PROPERTY-LIABILITY INSURANCE FIRM

The economic value of equity is given by :

$$K = A - L$$

with :

$$A = \sum_{t=1}^{t=T} R_t^A / (1 + r_a)^t$$

and,

$$L = \sum_{t=1}^{t=T} C_t / (1 + r_l)^t$$

A is the discounted value of the aggregate cash-flows, R_t^A, produced by the combination of assets held by the company. The value of policy reserves, L, is the present value of future losses payments arising from outstanding policies. A specific discount rate is used for assets and liabilities. Details as to their determinants will be introduced further in the discussion.

As a first step to specify the interest rate sensitivity of the equity value let's consider the expression of a small variation of K, dK :

$$dK = \partial A / \partial r_a \, dr_a - \partial L / \partial r_l \, dr_l \tag{2}$$

With reference to the definition of the duration given by equation (1), we then have :

$$\partial A/\partial r_a = AD^A \text{ and } \partial L/\partial r_l = LD^L$$

where D^A and D^L represent the duration of assets and liabilities respectively, and :

$$dK/K = (1 + L/K)D^A dr_a - L/K\, D^L dr_l \quad (3)$$

With reference to the structure of the economic balance sheet , it is pertinent to deal separately with the two components of total assets : invested assets[4] (I) and the goodwill (G). We shall note W^I and W^G the respective proportions of invested assets and goodwill in total assets, therefore, we then have :

$$A = I + G \text{ and } W^I = I/A\ ,\ W^G = G/A$$

Considering also specific discount rates r_i and r_g to estimate the value of each kind of assets, and distinct durations D^I and D^G, (3) can, then, be rewritten as follows :

$$dK/K = (W^I D^I dr_i + W^G D^G dr_g)(1 + L/K) - L/K\, D^L dr_l \quad (4)$$

Equation (4) provides us with a basis for the analysis of the interest rate sensitivity of the economic value of equity.

It exists an appropriate rate for any specific asset or liability, therefore, if we want to determine the rate sensitivity of a combination of different elements, as it is the case here, we need to select a rate of reference, and then define the relation which exists between this rate and each specific appropriate rate.

For any stream of cash-flows, the applicable rate r can be defined as the addition of the risk free rate (r_f) plus an appropriate risk premium (Φ).

$$r = r_f + \Phi$$

Taking r_f as the reference rate, and Φ' the first derivative of the risk premium with respect to r_f it follows[5] :

$$dr = dr_f (1 + \Phi')$$

Using the above definitions, from (4) we can derive the duration of equity (D^K) :

$$\begin{aligned} D^K &= dK/dr_f \,.\, 1/K \\ &= (1 + L/K)\,[W^I D^I (1 + \Phi_i') + W^G D^G (1 + \Phi_g')] \\ &\quad - L/K\, D^L (1 + \Phi_l') \end{aligned} \quad (6)$$

An immunisation strategy would require $D^K = 0$, which is obtained if the following condition is fulfilled :

$$W^I D^I (1 + \Phi_i') = L/A\, D^L (1 + \Phi_l') - W^G D^G (1 + \Phi_g') \qquad (7)$$

Equation (7) is a useful guide to now initiate a discussion about the investment strategy that insurance firms should implement if their objective is to control interest rate risk and immunise the shareholders' value.

INTEREST RATE RISK CONTROL

The right side of equation (7) mainly contains parameters which are contingent on the characteristics of the insurance business, whereas, the expression on the left hand side is essentially determined by decisions which financial managers can keep under control. First, the investment strategy determines the duration (D^I) and the risk premium (Φ_i) associated with the portfolio of securities held. Moreover, the proportion of invested assets (W^I) is dependent upon the level of retained earnings and capital increase.

We will proceed step by step and first consider that total assets is restricted to invested assets only so that $W^I = 1$ and $W^G = 0$. With this simplification we have :

$$D^I (1 + \Phi_i') = L/A\, D^L (1 + \Phi_l') \qquad (8)$$

D^L, the duration of policy reserves is a technical parameter mostly contingent on the delay between the moment when premiums are perceived and the average date when claims are paid. Therefore, since this delay varies significantly from different line of insurance to another[6], D^L depends on the structure of the business portfolio[7]. In property-liability insurance the average loss payment delay is usually assumed to be around two years.

Specifying Φ_l is more tricky, and requires assumptions as to the rate making process on the insurance markets. The amount of pure premium, P, received by the insurer (the portion of total premium allocated to policy reserves) can be seen as a precautionary saving deposit. This approach may not be relevant for an individual, but it makes sense if we consider a sufficiently large group of insureds. As such, this deposit should earn an appropriate interest at rate r_l. Then, we can write :

$$P (1 + r_l)^T = C_T$$

The initial amount P of pure premium, capitalised during T periods at rate r_l, should produce a final amount C_T, just enough to pay subsequent losses. In other words, P should correspond to the present value of future expected losses, from the above definition of P we also have :

$$P = C_T/(1 + r_l)^T$$

From this perspective, r_l should be the rate of return the policy holders can normally expect when they place their precautionary funds in the insurance firm. Although the role of the insurer is to reduce risk through the mutualisation process, there is always a residual risk remaining, which cannot be diversified. The price of insurance should then include a fair reward for the insurer who accepts this risk transfer from the policy holders. Therefore, we can expect r_l will be lower than the risk free rate, which means that Φ_l should be negative. The policy holders receive less than the risk free rate because they normally have to pay for the residual risk they transfer to the insurer.

Under the assumption of perfect financial and insurance markets, so that the capital asset pricing model (CAPM) applies, r_l can be precisely specified as follows :

$$r_l = r_f - \beta_l (E(r_m) - r_f)$$

The risk premium is a proportion β_l of the market risk premium measured as the difference between the expected market return ($E(r_m)$) and the risk free rate. β_l, the underwriting systematic risk[8], depends on the covariance between underwriting result (r_l) and the return on the financial market (r_m).

Assuming the following values for the parameters :

$r_f = 5\%$

$E(r_m) - r_f = 6\%$

$\beta_l = 0.2$

we obtain :

$r_l = 3.8\%$.

This estimate is close to the implicit rate obtained from underwriting losses recorded by the property-liability insurers[9]. However, this approach is of little practical relevance since it is most difficult to measure the underwriting systematic risk.

Moreover, due to a lack of competition or to the influence of regulators, the efficient market hypothesis may not be acceptable. In practice, insurance tariffs may not be influenced by the level of interest rate but instead determined with reference to the objective of maintaining the solvency of companies. In this case, r_l may not be sensitive to changes affecting r_f so that it exists no well specified immunisation strategy[10].

For the sake of discussion, let's now assume : $(1 + \Phi_i') / (1 + \Phi_l') \approx 1$, this would be the case for risk premiums independent of the risk free rate. Unity is obviously an upper limit since $(1 + \Phi_i')$ is normally expected to be greater than $(1 + \Phi_l')$. Then from (8) we derive :

$$D^I = L/A\ D^L \qquad (9)$$

The above equation indicates that immunisation is obtained if the duration of invested assets is not higher than a proportion L/A of the duration of policy reserves. Taking the average delay of losses payments (2 years) as a good estimate for D^L , and $L/A = 75\%$ as a realistic proportion (provided the goodwill is not included in A), then this means that the duration of assets should be one and a half year. Obviously this is far less than the observed duration of asset portfolios currently held by in account the goodwill component in the immunisation condition (7), then we can observe that the situation is still more delicate. Though it is extremely difficult to assess the magnitude of insurance companies, so that we can conclude that their risk rate exposure is presumably high.

If we now come to take D^G into account, we can reasonably assume it is positive for a profitable company, and rather high since late earnings are considered[11]. This suggests that the consideration of the goodwill obliges funds managers to reduce further the duration of invested assets. Yet, this stricter condition may sometimes be difficult to fulfil, particularly when investment opportunities available are restricted.

Condition (7) also indicates that the duration is not the only control parameter available to reduce interest rate risk exposure, two other elements must be considered : Φ_i' and W^I.

A safe investment policy would reduce the correlation between Φ_i and r_f and then it also reduces the impact of Φ_i'[12]. This observation reinforces the usual assertion which insurers cannot hold high risk portfolios if their objective is to maintain the solvency of the company[13].

W^I represents the proportion of invested assets in total assets. It can be partly kept under control through the dividends policy. For instance, more retained earnings would contribute to increase the amount of funds available for investment, and consequently increase W^I. Issuing new shares would create the same effect. This type of risk reducing strategy seems appropriate for a fast growing company, with high earnings prospects, and an important goodwill. Although more equity capital may not be required to maintain the solvency margin at the regulatory level, it can, nevertheless, contribute to reduce the weight of the goodwill in the economic balance sheet and help controlling the interest rate risk exposure.

Insurers can also decide to borrow long term funds. This strategy would increase the duration of liabilities and, simultaneously, reduce the weight of the goodwill in the balance sheet and increase the ratio *L/A*. Both effects contribute to increase the value of the right side element of equation (7), it, therefore, compensates for an important goodwill and provides more flexibility for funds managers, though more debt would also increase the leverage ratio.

CONCLUSION

In this paper we have focused our attention on the difficulty to assess and control the interest rate risk exposure of a property-liability insurance firm. In particular we have stressed the importance of hidden assets (goodwill) which represent a major proportion of the economic value of equity. The complexity of the problem is partly due to the variety of elements which have to be considered in the analysis and also the importance of subjective factors. We have also described strategies for controlling the risk.

This complexity may well explain a high volatility of insurance stocks when interest rates fluctuates. The reason would be a lack of rationality of investors on the market. Consequently, there have been major recent theoretical contributions likely to improve the market efficiency, as far as the insurance stocks are concerned, their diffusion is, however, restricted to a relatively small group of specialists. Also, we need more data investigations from which more precise conclusions could be drawn, this paper should be considered as a contribution to prepare this further step.

Notes

1 For instance James A. Tilley : Risk Control Techniques for Life Insurance Companies, in : Controlling Interest Rate Risk, Robert. B. Platt (editor). John Wiley & sons. 1986.

2 We have $\sum_{t=1}^{t=T} tR_t/(1+r)^{t+1} \Big/ \sum_{t=1}^{t=T} R_t/(1+r)^t = D_m(1+r)$, where *Dm* is a weighted average of cash-flows dates t. More developments about Macaulay type duration and its important role of interest rate risk analysis and management can be found in : Robert B. Platt. 1986. Controlling Interest Rate Risk. John Wiley & sons.

3 In the insurance community the term *goodwill* is sometime used to reflect the present value of future earnings coming from new business only.

4 If a portion of financial assets is not invested, this will contribute to reduce the average expected return on total financial assets.

5 If we can assume the validity of the CAPM (Capital Asset Pricing Model), then $\Phi = \beta\ (E(r_m) - r_f)$, the risk premium is a proportion β of the market risk premium measured as the excess of the expected market return on the risk free rate. Though, the CAPM approach is sometime used to analyse the financial and pricing strategies in the insurance sector (see William B. Bailey mentioned in note 4) we will not refer to it in the present paper.

6 Concerning these technical aspects, details can be found in : William B. Bailey. 1979. Investment income and profit margins in property-liability insurance : theory and empirical results. *The Bell Journal of Economics* 10 : 192-210.

7 We assume here that the « insurance portfolio » is structured prior to asset allocation , we therefore take it as an exogenous element. This hypothesis is realistic though restrictive from a theoretical point of view since assets and liabilities should be considered as two components of a unique portfolio.

8 The concept of underwriting systematic risk was first introduced by Biger N. and Kahane. 1978. Risk considerations in insurance ratemaking. *Journal of Risk and Insurance*. 45. March 1978 : 121-132.

9 Estimates can be found in : Patrick Gougeon. L'assurance dommages face au risque de taux. Revue d'économie financière. N° 11. Décembre 1989 : 185-195.

10 On this particular point see reference 8.

11 For an in depth analysis of determinants of D^G the reader can refer to : William H. Panning. 1995. Asset Liability Management for a going concern. In :The Financial Dynamics of the Insurance Industry, (chapter 12). Edited by E.I. Altman & I.T.Vanderlhoof, New York University. 1995.

12 For instance, if we take : $r_i = r_f + \beta_i\ (E\ (r_m) - r_f)$, a lower β_i would reduce the sensitivity of r_i to r_f.

13 Arguments to support this assertion can be found in : Patrick Gougeon. Gestion financière de la firme d'assurance : l'allocation des actifs. Banques et Marchés. N° 23. Juillet Août 1996 : 46-53.