Dynamic Optimized Asset and Liability Management for Participating Life Insurance Policies: the China Case

Abstract:

On account of the new regulation policy, stronger competitions and much more uncertainty of the capital markets, the importance of stochastic asset and liability management (ALM) models has been valued by life insurers. In this paper, we study the problem of asset and liability management of participating life insurance policies for the case of China. We attempt to structure both the participating policy and the investment portfolio for life insurers and develop a dynamic optimization model for integrative asset and liability management in order to analyze the tradeoffs between the parameters of the asset side and the liability side. We try to cover the most important characteristics of the two sides of ALM, including the mortality, the surrender, the bonus declaration rule and the asset allocation strategy, the interest rate term structure, the stochastic capital market. Furthermore, we extend the base model to some more realistic situations. One for insurers to design the characteristics of policies based on their investment ability and the capital market circumstance and for the other one, we loosen the hypothesis that policyholders only come in at the very beginning. We report the empirical analysis of policies offered by Chinese life insurers. It show the relationships between the parameters in the model and could help the insurers to analyze the alternatives, such as different bonus rules and asset allocation strategy.

1. Introduction:

Because of the growth spurts of the internet finance in the recent three years, there has been a dramatic move of Chinese household's wealth, especial the deposits, towards higher return investment vehicles, such as the internet money fund and bank financial products. Life insurers have to compete for the same funds from the households only by introducing higher return rate than before. In China, the participating life insurance policies account for more than 80% in the scale of total premium income. A representative participating policy often include guarantees on the minimum return rate, bonus provisions and surrender options for the policyholders. All these features make the policies more attractive to the household who are not only need an insurance product but also an investment vehicle. On the other hand, the volatility of the Chinese capital market has been significantly increased and for the market interest rate the government has announced to accelerate its liberalization which would lead it to fluctuate more free. The more fluctuated interest rate and uncertainty of capital market would bring much more investment risk to insurers and insurers have to use stochastic ALM models instead of the traditional static models.

According to the definition of ALM in SOA Asset-Liability Management (ALM) Specialty Guide (2003) we know the insurers' financial objective of ALM is to make the available capital be invested in higher rate of return (asset management) and the constraint is the obligations against policyholders (liability management). So we divided the decisions and actions taken by insurers into two part, one is respect to assets which is the problem of optimally structuring the portfolio and the other one is respect to liabilities which is the problem of optimally designing the policies.

In this paper we consider multi-period guarantees policies with bonuses that are paid at each sub-period and are subsequently guaranteed. The bonus is contractually determined as a fraction of the portfolio excess return above the guaranteed rate during each sub-period. Then we present the insurers' portfolio selection and policy design problems as a non-linear mathematical program with stochastic variables. We build a base model which the mortality and surrender rate are given and the policyholders can only buy the products at beginning and the insurer can only set his investment strategy and design the structure of policy at beginning too. This means that all the decisions are made

when business starts.

2. The preliminary description of the model

We have the simplest balance sheet for insurers which only have three components: asset, liability and equity. The plot line of our model is as below figure shows. For the base model, we just set the portfolio selection decisions (α) and the policy design decisions (β) at t=0, which mean that they are not the function of time to maximize terminal utility of insurer.

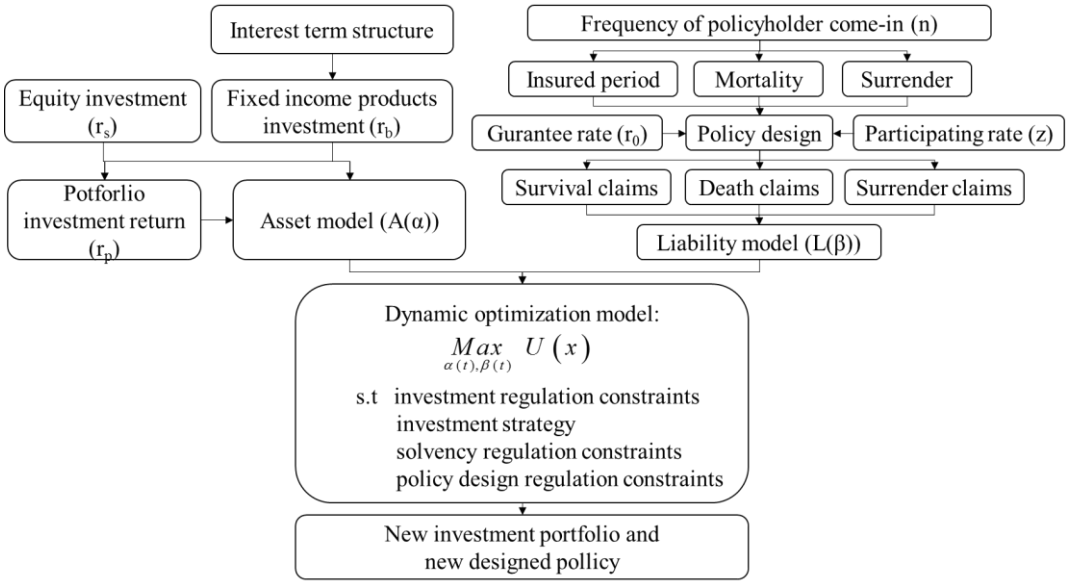

Fig. 1 the plot line of ALM model

Then we elaborate the models by taking consideration of stochastic dynamic optimization in it.

(1) Constant beta and dynamic alpha with only one time policyholder come-in. $(\alpha = \alpha(\beta, r_s, r_b, t))$

Here we have been simulating the performance of insurers under new condition that the insurers will rearrange the portfolio selection at the beginning of each sub-period so that they could make his investment decisions dynamically to maximize its objective function. The forms of the objective function are respect to insurers' operation philosophy which would be different from each other. We will to analysis the differences of the performance of insurers between the dynamic optimization in asset allocation model and the base model.

(2) Constant alpha and dynamic beta with multi-periods policyholder come-in. $(\beta = \beta(\alpha, r_s, r_b, n, t))$

Here we will consider the model with multi-period policyholders which means that policyholders can buy the products every several periods. Compared with the base model, this hypothesis reflect the realistic situation and insurers can design different policies, especially the guarantee rate to increase its attraction, when new policyholders come in. We will analysis the relationship between the dynamic guarantee rate and the insurers' performance to see how the guarantee rate liberalization influence the insurers' decisions.

(3) Constant beta and dynamic alpha with multi-periods policyholder come-in. $(\alpha = \alpha(\beta, r_s, r_b, n, t))$

This situation just changes the frequency but the total portfolio selection decisions may be different from the first one. We want to see the detail differences that be brought by the frequency and hope there are some valuable results for the insurers.

3. Existing literature review

Along with the development of the participating life insurance policies, there is a growing literature directly on the pricing problem. The first papers on pricing of the option embedded in the production with guarantees are Brennan and Schwartz (1976) and Boyle and Schwartz (1977) and they analyzed unit-linked maturity guarantee policies. Until

recently, Grosen and Jørgensen (2000) has made a relative more complete analysis of modern life insurance products and they decomposed the insurers' liability into three parts, a risk-free bond, a bonus option, and a surrender option. Obviously the pricing problem of the embedded options is greatly dependent on interest rate so an appropriate stochastic interest rate model has been applied. Miltersen and Persson (1999) analyzed the pricing problem of insurance products with minimum guarantees in the interest rate framework of Heath et al. (1992). Bacinello (2001) study the interplay between the volatility of the underlying asset portfolio, the participation level for determining bonuses, and the guaranteed rate.

It is very important to note that these literatures above assume that the insurers' asset portfolios are given exogenously when pricing the policies and don't analyze the problem of structuring the asset portfolios optimally. Independently from those literatures, there are many in the use of portfolio optimization models for ALM analysis. Cariño et al. (1991) present the Yasuda Kasai model which become the most prominent example. Other successful examples include the Towers Perrin model of Mulvey and Thorlacius (1998), the CALM model of Consigli and Dempster (1998) and the Gjensidige Liv model of Høyland (1998). Jensen and Sørensen (2002) ask whether products with minimum guarantees really serve investors interests, with interesting conclusions. Consiglio et al. (2001) demonstrate that the firm could substantially increase shareholder value by considering the integrated asset and liability management problem of structuring the firms portfolio optimally.

As a whole, the ALM models can either be achieved by the computation of particular scenarios (stress tests) which are based on historical data, subjective expectations, and guidelines of regulatory authorities or by a stochastic modelling and simulation of the market development, the policyholder behavior and all accounts involved. Recently researchers has paid more attention to the stochastic modelling approach since it takes financial uncertainties more realistically into account. Much effort has been spent on the development of such models in the last few years; most authors focus on the fair valuation and contract design of unit-linked and participating life insurance policies. But we can see that most of the articles in the existing literatures restrict themselves to single-premium contracts and neglect mortality to simplify the presentation or to obtain analytical solutions. However, Bacinello (2005) tell us in the presence of surrender, generalizations which include periodic premiums and mortality risk are not always straightforward.

4. Possible contributions of this paper

In our paper, we first build a base model which includes the most common characteristics appeared in the previous existing models. We develop a stochastic optimization asset and liability management model for multi-period participating policies. Our model could optimize the portfolio selection or the policy design to guarantee the contractual obligations while maximizing the insurers' objective function.

The possible contributions of our paper may be as follows:

1. A model that give out a dynamic optimization decisions for portfolio selection during the whole product lifetime. The existing literatures usually focus on the decisions at the very beginning and keep the decisions, such as investment strategy and policy designing, unchanged in following periods. If the duration of the policy is relatively short, this decision rule may be usable, but for life insurance products which would last twenty or thirsty years, fixing the strategy would not make sense.

2. A model that consider continuous policyholders flow during the whole product lifetime. We want to analyze whether the decisions of insurers would change in this situation. In real business circumstance most life insurance products are not only sold once at the beginning, and the continuous policyholders flow means a continuous cash inflow and increasing insurance liability. All the different features will be our research focus.

3. A benchmark of the policies offered by Chinese insurers against optimized policies. We will see what are different and how Chinese insurers could improve their asset-liability management system.