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DESIGN OF LIFE INSURANCE PARTICIPATING POLICIES WITH VARIABLE GUARANTEES AND ANNUAL PREMIUMS

Perla Rocio Calidonio-Aguilar and Chunhui Xu

Depterment of Management Information Science
Chiba Institute of Technology
2-17-1, Chiba 275-0016, Japan
{ rocalidonio_jp; xchunhui }@yahoo.co.jp

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Abstract. *This paper deals with the design of a life insurance participating policy with annual premiums. Participating policies guarantee a minimum interest rate at the end of each policy year and an additional interest rate may be credited to the policyholder according to the annual performance of the insurer's investment portfolio. Particularly, we consider the case in which the minimum interest guarantee is adjusted periodically. Moreover, the policy offers the policyholder the right to terminate the contract before maturity in exchange for its cash value. Differing from previous research, we consider a policy with features that make it more similar to real insurance products found in the market. Furthermore, with the use of optimization techniques, we put forward an approach for deciding an optimal set of contractual rates and annual premium for the participating policy under scrutiny. To the best of our knowledge, this is the first work to address the actual design of such participating policies.*

Keywords: Participating policy, Guarantee rates, Annual premiums, Fair valuation, Optimization

1. **Introduction.** Life insurance participating policies, also known as with profits policies, are important financial products that have become popular over the years as a means of achieving long-term growth of capital. These policies offer a basic benefit, which is determined at the inception of the contract, and guarantee that the value of policy will grow by at least a minimum rate each year, this rate is called guarantee rate. Additional interest, which is often referred to as participation rate, may be credited according to the performance of the company's investment portfolio. Most participating policies give the policyholder the right to terminate the policy before maturity in exchange of its cash value. This type of policies poses a great challenge to every insurance company, because products with such appealing features are difficult to design and price accurately, and any mistake in the process could have disastrous financial consequences.

There is rather abundant literature addressing the valuation of participating policies with guarantees, for example, [1-7]. In regard to the valuation of participating policies with guarantees and surrender option, we found valuable contribution in [8-10]. Although, in the literature, many important contributions have been reported, there are several important issues that have not been considered. The aforementioned works have not taken into account the fact that one of the insurers' goals is to make a profit. Previous research has solely focused on the fair valuation of the policy; that is, the premium of the policy is calculated so that it equals the market value of the benefits to the policyholder, which, in turn, represents the insurer's expenses.

There are other issues that have been left out in previous works. In reality, the guarantee rate offered by the policy is more likely to change throughout the life of the policy rather