Multiobjective optimization for the asset allocation of European nonlife insurance companies

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Multi-objective optimization for the asset allocation of European non-life insurance companies

Abstract

An optimal asset allocation is crucial for non-life insurance companies. The most previous studies focused on this topic use a mono-objective technique optimization. This technique usually allows the maximization of shareholders' expected utility. As non-life insurance company is a complex system, it has many stakeholders other than shareholders. So, the satisfaction of the shareholders' expected utility cannot lead usually to the satisfaction of other stakeholders' objectives. Therefore, the focus on utility maximization can be a destruction source of other objectives such as productivity, competitiveness and solvency. Our developed model integrates simulation approach with a Multi-Objective Particle Swarm Optimization algorithm. This model insures an optimal asset allocation that maximizes, simultaneously, shareholders expected utility and technical efficiency of European non-life insurance companies. The empirical application conducts a comparison between the attained results with multi-objective optimization technique and mono-objective technique to search the optimal asset allocation for non-life insurance companies. Our results show that the investment portfolio will be more diversified between most available investment assets. In addition, any decision maker should take account of different stakeholders' objectives. Accordingly multi-objective optimization allows us to find the best asset allocation that maximizes simultaneously expected utility and technical efficiency of non-life insurance companies.

Keywords: Simulation; Multi-objective particle swarm optimization; Asset allocation; Technical efficiency; Shareholders expected utility; European non-life insurance companies.

1. Introduction

Every non–life insurance company searches the optimal asset allocation to insure its solvency and competitiveness. An appropriate asset allocation makes adequate returns that maximize shareholders' expected utility. Also optimal asset allocation makes available liquidity for claim payments. Inadequate returns, excessive risk and illiquidity have a negative influence on shareholders as well as on customers. If the insurance company doesn't seek to invest optimally its available funds then its insolvency probability will increase excessively and/or the insurer will require high premium rates.

Most previous studies focused on a single-objective optimization. Usually they seek the optimal asset allocation that maximizes shareholder's expected utility (Yu et al (2010)). But in reality the insurance company is a complex system in which one can find several stakeholders. A stakeholder is every organization or person has a direct or indirect interest in the company insurance activities. Often the objectives and perspectives of the shareholders are not the same as the other stakeholders and they come into conflict. Usually shareholders have interest to maximum short-term profits and in case of insolvency or bankruptcy is always the officer who will be responsible for the excess risk. By cons other stakeholders, especially Customers, have interest to competitiveness, productivity and efficiency of the company insurance because these insure its solvency, its survival and long-term returns. When the insurance company is more competitive, it will require low premium rates.

When it attempts to optimize its asset allocation, the insurance company must consider the different stakeholders and different perspectives in order to not favor one of them and neglect the other objectives. So in addition to the shareholders' utility maximization, the insurance company is asked to ensure its competitiveness by maximizing productivity. In other terms each insurance company must maximizes its technical efficiency i.e. achieve the maximum desirable outputs with minimum inputs and undesirable outputs.

This research work aims to investigate the optimal asset allocation that maximizes simultaneously shareholders' expected utility and technical efficiency in the European non-life insurance companies. First we simulate five types of assets in which the insurer can invest. Then we specify the objective functions that must be optimized. For shareholders' expected utility we adopt the utility function used by (Yu et al (2010)). For the technical efficiency we use the directional output distance function proposed by Färe et al. (2005) that allows a complete characterization of the production technology frontier. To search the optimal asset allocation, that optimizes simultaneously our objective functions, we opt for the Multi-Objective Particle Swarm optimization algorithm. It is one of the newest techniques within the family of evolutionary multi-objective optimization algorithms. We apply our model on a sample of 175 non-life insurance companies dispersed in nine European countries over the period 2002-2008.

Our paper research is structured as follows. In the next section we survey some related works focused essentially on the major asset allocation methods and multi-objective optimization techniques. Section 3 illustrates our model, including assets definition, objective functions and the MO-PSO used technique. Section 4 describes dataset, variable definitions and empirical results. Finally section 5 concludes the paper.

2. Literature review

2.1. Optimal asset allocation in insurance companies

There is a rising concern about asset allocation for insurance companies. Often insurance studies use the capital word to designate available funds for investment, also called surplus. Our paper focuses on the surplus' investment of non-life insurance companies, and how this

surplus can be optimally allocated. According to Mayers and Read (2001) rising surplus is collateral for policyholders. These authors note that surplus is costly, and as consequence, the competitive premiums are influenced by total surplus requirements and their allocation. In a competitive environment, a false surplus allocation may lead the insurance company to lose profitable allocations to other competitors.

Two principal approaches offered by literature to resolve the asset allocation problem for insurance companies. The first approach is an extension for the paper of Markowitz (1952) the pioneer of mean-variance analysis. The general idea of this approach is to generate an efficient frontier in return-risk' space. This frontier includes all most efficient portfolios in which investors invited to invest. The mean-variance analysis is an extension of the previous approach that takes account, in some studies, of liability side for financial institutions (Chiu and Li 2006; Craft, 2005, Sharpe and Tint 1990). According to Brennan et al. (1997), the use of an unsuitable investors' utility function is the most striking criticism addressed to this analysis. The second approach to build an optimal portfolio inspired from Merton (1971, 1990). The literature that follows this approach considers the asset allocation problem as stochastic and the solutions are illustrated by Hamilton-Jacobi-Bellman partial differential equations (Yu et al. (2010)).

Many research works investigate the optimal asset allocation in insurance companies. Moreover, the significant magnitude of surplus returns in the net income and the considerable evolve in the financial investment regulation, push us to renew interest to answer the question, how an insurance company can allocate its surplus optimally (Mayers and Read (2001)). Kahane and Nye (1975) and Cummins and Nye (1981) are among the first researches who deal this question for a single period. Browne (1995) enriches this research question and treats it in a dynamic framework. His principal result is that an optimal strategy involves investing a fixed amount in risky asset regardless of the surplus amount. By against the results of Hipp and Plum (2000) show that optimal amount invested in risky assets should be based on the current surplus. The difference between the two previews research results due to the model characterization (Mayers and Read (2001)). Liu and Yang (2004) extends the model of Hipp and Plum (2000) by taking account of risk-free asset. Yu et al. (2010) apply a simulation model to search the optimal asset allocation that maximizes shareholders' utility function for non-life insurance companies. The authors develop a new evolutionary algorithm while taking account of multi-periodic condition in the asset allocation problem. They show that their model is more effective than other algorithms which optimize mono-periodic problems. Most of these studies search to optimize a single objective either maximize shareholders' expected utility. As shareholders are generally risk-averse, the focus on utility maximization can be a destruction source of other objectives such as productivity, competitiveness and solvency. So the insurance company is a complex system and has to search the optimal asset allocation that maximizes many objectives simultaneously. In the next paragraph we present some proposed techniques to resolve multi-objective problems.

2.2.Multi-objective optimization methods

The principles of multi-objective optimization are different of that in a mono-objective optimization. However, in multi-objective optimization, there are at least two objective functions and each one has its own optimal solution. If these individual solutions are significantly different than their corresponding objective functions are usually recognized as conflicting to each other. So, multi-objective optimization aims to find a set of solutions defined as non-dominated instead of a single advocated solution in the case of mono-objective optimization. In a multi-objective problem a solution is called non-dominated, or Pareto