Encylopedia of Quantitative Risk Assessment

ALM for life insurers

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1 Introduction

Asset-Liability Management or Asset-Liability Modelling (ALM) for a life insurer is a quantitative approach to assessing risks in both the liabilities and the assets and developing risk management strategies incorporating asset allocations, capital provisions, derivatives and reinsurance. An important objective is ensuring asset cash flows meet liability cash flows over long terms. ALM for a life insurer requires valuation and projection of complex cash flows contingent on a wide range of risks including human mortality, sickness, interest rates, equity returns, inflation, exchange rates. With the increase in computing power, ALM has become a powerful risk assessment technique for life insurers.

2 Products and Risks of Life Insurers

Life insurance companies provide coverage for risks related to human mortality, survival as well as health and disability. They pool large numbers of life insurance risks and as a result benefit from the law of large numbers in the variability and prediction of expected future claim payments. They also issue contracts that provide a long term savings benefit linked to mortality risks. Life insurance contracts are for long terms compared to non-life insurance. They involve guarantees to make payments for many years in the future. Whole of life insurance and annuities involve payments depending on death or survival for as long as the oldest age of survival of the lives insured. This is the ultimate age in the life table for risk modelling purposes. For example an annuity could involve a commitment to make payment to an age of 120 years in the case of a

life annuity. Obviously such occurrences are relatively rare events but improvements in mortality and also pandemics can impact mortality risk across a range of ages. Term insurance contracts provide cover for periods as long as twenty or thirty years. Long term savings products usually have terms of at least 10 years.

Life insurance contracts can be participating with-profits, with a bonus payable on a regular basis depending on the surplus arising on the insurance business. Once the bonus is paid it becomes a guaranteed part of the life insurance contract adding to the obligations of the company. Bonuses may also be paid on maturity or termination of the contract, in which case they are referred to as terminal bonuses. For non-participating contracts the payments are mostly fixed or linked to an index such as the Consumer Price Index (CPI) in the case of indexed annuities. The amount of the payment can be estimated with a high degree of confidence. For a large number of lives insured, the expected claims payments on death or survival can be estimated. Mortality improvements can cause some uncertainty in the estimate of future payments but an allowance is usually made for this.

Even though the policies are issued for long terms, in many cases the policies terminate due to lapse or surrender prior to the maturity date of the policy. A policy lapses when a policyholder does not pay the premium and no contractual payment is owed to the policyholder. A policyholder can also surrender their policy prior to the maturity date of the policy and receive a payment on the policy. This payment is called the surrender value. Often the surrender value is guaranteed. A minimum surrender value is usually required by life insurance law in many countries. Maturity benefits on savings products and also death benefits on life insurance contracts may also be guaranteed in the form of an investment guarantee. For example, a guarantee on a life insurance policy could be a minimum benefit of a return of premiums with a specified and fixed interest rate in the event of death or surrender after a minimum term. This is often a requirement of life insurance legislation in many jurisdictions. Guarantees in life insurance policies have the same features as financial option contracts such as puts and calls although they are far more complex since they depend on investment returns as well as mortality and withdrawals and extend over very long terms.

Lapses and surrenders are hard to forecast because they can depend on future economic conditions. For example if there is a recession then policyholders with savings policies may need to surrender the policies to access their savings to cover short term needs. If earnings rates offered on competitor savings products are higher, then this can also lead to surrenders of these policies.

Life insurance companies receive premiums from policies and invest these funds in assets in order to satisfy claim payments as and when they fall due. Assets include short term cash investments, fixed interest securities, shares and property investments as well as various alternative investments such as hedge funds and insurance linked securities. They also insure their own risks by purchasing reinsurance from specialist reinsurance companies.

3 ALM for Interest and Mortality Risk

Penman (1933) was ahead of his time when he identified the problems that arise in asset-liability management resulting from too generous guaranteed surrender values. He also noted the increased importance of currencies, commodities, inflation and income tax in asset-liability management in the early 1900's. He discussed the idea of matching the currency of the assets and the currency of the life insurance contracts and the role of property and ordinary shares in matching inflation. The importance of diversification by geographical area and type of security was also recognized. In the discussion of the Penman paper, C. R. V. Coutts highlighted the need to "marry" the asset and liabilities as far as possible, by which he meant holding investments that were repayable at a time to cover contract payments from the fund over the following forty or fifty years, an asset-liability management strategy known as matching.

However it was Redington (1952) who developed the principle of immunization of a life insurance company against interest rate movements. Assets were to be selected so that the discounted mean term, or duration, of the asset and liability cash flows were equal and that the spread of the assets cash flows around their discounted mean terms, referred to as convexity, should exceed the spread of the liabilities around their mean term. These ideas became the foundation of life insurer ALM for many years until the adoption of more advanced option pricing and modeling techniques following the Nobel prize winning work of Black and Scholes (1973). These risk modelling and assessment approaches have been extended in more recent years. The early ALM for life insurers was designed for interest rate risk management and fixed interest or interest sensitive assets and liabilities. As noted in Sherris (1992), matching can be considered as a special case of asset-liability portfolio selection under risk and capital constraints for the life insurer. Panjer (1998) covers ALM for interest rate risk and ALM portfolio selection of assets to allow for liabilities.

Modern ALM for life insurers extends beyond interest rate risk and measuring the duration of assets and liabilities to a broader range of risks that can adversely impact the financial performance of the company. Immunization techniques were developed for fixed cash flows whose values were dependent on interest rates. Modern option pricing models allowed these to be extended to interest sensitive cash flows.

Over the last decade or more, longevity has become an important risk to be assessed by life insurers particularly for life annuity and pension policies. As individuals increase in life expectancy the value of life annuities increases. Selecting assets to manage and match longevity risk is difficult since markets in long term securities are limited and there is only a limited market in mortality risk unlike the markets for credit, interest rate and equity risk. Securitization is an increasingly important risk management technique in ALM for life insurers and mortality risk. The importance of mortality risk is highlighted by the recently created web site www.mortalityrisk.org containing a rapidly growing collection of research including ALM issues.

4 Quantifying Risks for Life Insurers

In order to quantify and assess the financial risks of a life insurer specialized ALM projection software is used to model both the assets and the liabilities. Since the liabilities consist of many policies, it is common to group those policies with similar features using model points and to project these groups of policies. Similarly for assets, where cash flows on portfolios of similar types of assets are projected. The projections use an economic scenario generator to allow for interest rates, inflation, equity and property returns and models of liability cash flows allowing for mortality, lapses, surrenders and maturities as well as the benefit guarantees.

Modern financial concepts and techniques from option and contingent claim valuation theory are used to derive market consistent valuations of assets and liabilities. The models are also used to assess risk based capital and reinsurance requirements, both very important components of the risk management strategy of a life insurer. Simulation of future scenarios is commonly used in these projections, although the computational time taken to perform a complete ALM risk assessment requires the use of modern and fast methods of computation. These include quasi-random numbers and other variance reduction methods.

Since most life insurance products contain guarantees and other option features, using standard cash flow projection techniques will not properly assess the risk in the cash flows. Stochastic projections are essential in order to quantify the adverse outcomes, which may be when options in both liability and asset cash flows are exercised. For example, policyholders exercising surrender options when interest rates are high and asset values are reduced. The actual valuation of life insurer obligations allowing for the guarantees and options will usually substantially exceed the value ignoring these options. ALM can be used to project the outcomes where the life insurer is most at risk and to also quantify the cost of managing or reducing the risk.

Dynamic modelling including stochastic optimization has the potential to improve the risk assessment and management of life insurers. These techniques are used increasingly in ALM for non-life insurers. The long term nature of life insurance cash flows presents new challenges for the application of these techniques.

5 Conclusion

ALM is a critical component of a quantitative risk assessment for financial performance and to ensure a life insurer can meet policy obligations. Risk assessment modelling has developed over a number of years to highly sophisticated cash flow projection and valuation models incorporating modern developments in financial risk modelling and valuation. A detailed coverage of many of these techniques is found in Ziemba and Mulvey (1998).

References

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