IMMUNIZATION IS DEAD

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ABSTRACT

Immunization theory died because it has not addressed the present requirements for overall asset liability strategies. This paper examines

- the assumptions which form the basis of the theory and their restrictions
- the practical problems associated with the theory
- an alternative model to replace the immunization theory based on cash flows.

1. OBITUARY NOTICE

With deep regret I have to announce the death of Immunization. Immunization was born at Staple Inn, London in 1952 and was brought to the attention of life actuaries by Redington (1952). It quickly gained approval as a life fund investment strategy during the 50s and early 60s and it became one of the basic U.K. actuarial philosophies of the day. However, during the late 60s and the early 70s, due to the enormous growth of equity (stock) investments, the theory suffered several setbacks. In the early 80s it had a revival in that companies began to measure their deviation from the Immunised Fund.

However Immunization looks at present values of the separate streams of asset and liability cash flows and does not investigate net cash flows (income less expenditure) at any particular time. Further it was stretched, incorrectly, to accommodate general insurance funds. These fatal flaws have caused its final demise. So, with great regret, it is announced that immunization theory passed away in 1992, leaving no direct heirs but a cousin called Matching.

Immunization developed because it enabled an overall investment liability strategy to be understood. This obituary briefly examines

- the assumptions which form the basis of the theory and their re-

strictions

- the practical problems associated with the theory
- an alternative model to replace the immunization theory based on cash flows.

2. Immunization

Redington (1952) stated:

- "Immunization implies the investment of assets in such a way that existing business is immune to a general change in the rate of interest"

  and

- "Matching implies the distribution of assets to make them equally as vulnerable as the liabilities to those influences which affect both"

For the above to be achievable the following must apply:

2.1) All assets must be in fixed interest bonds (with fixed redemption dates).

With reduced supply of fixed interest government bonds (because the governments are reducing their debts) and with a large growth in equity investment due to equities out-performing fixed interest bonds in the medium term this is arguably not the best investment strategy for the company.

2.2) Assets with long enough mean term exist, liabilities are on average short term but the liability spread may be considerable.

2.3) If the force of interest changes then it is required that the change in the force of interest is the same throughout the (fixed interest bond) yield curve.

However normal changes do not give a shift in the yield curve but a change in the shape of the yield curve. In particular, recently there have been significant fluctuations in interest rates and hence in the shape of the yield curve.

2.4) The force of interest throughout the term of the liabilities must be constant.

Is this ever achieved ?

2.5) You can predict the asset proceeds with certainty.

2.6) You can predict the liability outgo with certainty.

2.7) To highlight some of the practical problems with the theory and show that the theory's restrictive investment strategy is to the detriment of the fund it is worth expanding one of the above points. Let us consider point 2.1.

The following example is taken from Coutts and Clark (1990).

Suppose that we have a liability of £110 to meet in one year's time. Suppose further that we can purchase a one year zero coupon bond with a redemption yield of 10%.

If we currently have assets of only £100 then we can invest them all in the bond and ensure that we can meet the required payment in one year's time.

Suppose that we have assets of £101 and that we are also permitted to invest in equities. The expected total return (dividend income combined with capital growth) on equities for the coming year is 15%; however returns of +25% and +5% are also possible.

The conventional approach might be to invest £100 in the bond and £1 in the equity. Consider though an investment of £22 in equities and £79 in the bond. As the table below shows, in both cases we still have sufficient assets to meet our liability at the end of the year.

Amount of bonds	£100.00	£79.00
Amount of equities	£ 1.00	£22.00
Return on equities	Proceeds at the end of the year	
+25%	£111.25	£114.40
+15%	£111.15	£112.20
+ 5%	£111.05	£110.00

If we fear that the worst we can expect is a return on equities of minus 10% over the year then we can still invest £5.50 in equities and the remaining £95.50 in the bond. If our fears are realised then at the end of the year we can still meet our liability:

$$(£95.50 \times 1.1) + (£5.50 \times 0.9) = \$110$$

Investing only the free reserves in an asset class which we expect to provide a higher return implicitly assumes that the investor believes this asset could be valueless at the time the liability is to be met.

3. Further practical problems

Apart from the problems mentioned above (which are all well known) the following additional comments can be made.

3.1) The theory does not take into account explicitly

- asset variation
- liability variation
- timing of payments of assets and liabilities
- alternative asset distributions

3.2) As mentioned the theory was developed for life funds . It was extended to general insurance funds where both liability values and the timing of payments are both uncertain. To overcome these problems the concept of a closed fund and the matching of assets and liabilities emerged. The investment strategy was called "Matching", because it attempted to match liability payments with asset maturities. However the matching concepts ignored

- new business growth
- the uncertainty of liabilities
- the uncertainties of timing of payments.

Hence immunization's cousin (Matching) still ignores these fundamentals.

3.3) Immunization theory is not an analysis of explicit net cash flows at a particular time. Cash flow problems can cause a company to become insolvent, in that when liabilities become due and forced sales are required the cash value of the assets may not be sufficient even though on a continuing basis the present value of assets are. Therefore consideration of cash flows is fundamental to any investment philosophy.

3.4) Profit is immunised as well as loss.

3.5) There are better ways of investing which can increase your investment returns thereby reducing the exposure of the company to insolvency. For example:

Equities have historically out performed fixed interest investments.

The advent of futures and derivatives are totally outside the theory. For instance use can be made of put options to protect the value of an equity fund.

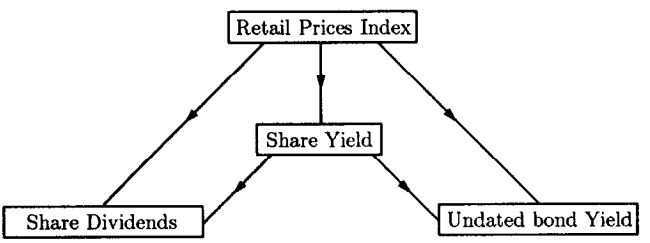
3.6) With changes in interest rates and new business, frequent changes of the investment portfolio are required.

4. What can be done?

4.1) Giant leaps in computer technology together with developments in stochastic modelling and simulation techniques mean that we can return to the more general question of asset-liability modelling, i.e. take into account factors that influence cash flow inter alia, timing of liability payments, relationships between claim inflation and economic inflation, the value of assets, and the effect of different asset distribution.

4.2) What is required (apart from the computer hardware) ?

A stochastic model of the investment scenarios such as that given by Wilkie (1986). This model is a cascade economic model which will allow for the inherent link between variables such as rates of return and inflation. An example of a cascade model is shown below:



4.3) A consistent stochastic model of the liabilities as per Daykin et al (1987).

4.4) A structured algorithm for the asset-liability model (as per Daykin et al (1987)) below:

Algorithm

1. Project Premium Income
2. Generate total claim amount
3. Generate cash inflow of interest plus maturities using model
4. Compare income inflows and claim outflows
5. Follow investment or dis-investment rules
6. Repeat process until all liabilities have run off
7. Remaining assets - measure of strength
8. If negative, then insolvent
9. Repeat process 1000 times.

In the above Algorithm, Immunization is one particular case (subset) of the model.

In addition Coutts and Clark (1990) extend the concepts to the allocation of assets using efficient frontiers of Modern Portfolio theory and proposed such questions as:

a) What asset distribution is implied by assuming that we wish to minimise (at the 10th percentile) the probability of the solvency margin falling below 40% whilst maximising (at the 75th percentile) the expected solvency margin?

b) What asset distribution is implied by assessing the measure of strength annually as opposed to just at the end of the run off of the claims?

5. Summary

Even though immunization has died it has sown the seeds of a more generalised investment strategy model. It is hoped that the next generation of actuaries will take up the mantle and develop an effective cash flow model which can be used by management.

Bibliography

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