Surplus in investment strategy due to mismatch with liabilities.

by John C Burville

BIOGRAPHY:

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ABSTRACT:

P&C Insurance companies hold more fixed interest securities than are necessary to offset the stated liabilities. Furthermore, the cash flows of these assets are biased towards longer durations.

If the fixed interest assets could be segregated into those assets intended to offset the liabilities, and other assets, interesting observations can be made concerning the investment strategy. There are several methods of segregating the assets, and each will produce different effects on the duration of assets underlying the liabilities and those underlying surplus.

Assuming no changes to the predicted liability outflows, there will be inherent interest and asset risk due to mismatch of cash flow streams between the assets and liabilities. This paper provides a means of measuring the amount of surplus used in the investment strategy due to the mismatch of the cash flow streams.

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In the move toward discounting, risk based capital, market valuation, and asset/liability relationships, surplus comes under increasing scrutiny. Much of this scrutiny is in the area of risk on the asset side of the balance sheet. Steve Philbrick in his brainstorm in "The Actuarial Review" of August 1991, points out that 1/3rd of the risk to capital is from assets. This paper focuses upon one component of asset risk, i.e. the amount of surplus assigned to the investment strategy for those assets needed for liabilities. To measure this amount of surplus, the assets underlying the liabilities need to be defined or reasonably estimated.

Traditionally in the P&C insurance market, if assets were specifically segregated to offset the liabilities, those assets would not have identical cash flows to the predicted liabilities. Consequently, surplus is invested in the investment strategy either to protect against changes in the liabilities, or to provide greater opportunity for investment gains. This paper estimates the amount of surplus assigned to the investment strategy in respect of the mismatch between the asset cash flow and the liability cash flow.

In most companies assets are not specifically assigned to liabilities or surplus. Nevertheless, if assets could be separated, the corporate requirements of the use of assets for surplus funds versus policyholder liabilities would be very different. Clearly, even if specific assets were set aside for the liabilities, they would not provide identical cash flows to those needed for the liabilities (even if the liabilities were not uncertain). Inconsistencies in maturity, interest payments, liquidity, and options preclude any precise cash flow matching.

The topic of this discussion will be limited to two parts. The first part will focus upon assigning or selecting assets which are sufficient to settle the liability payout estimate. While the second part will measure the amount of surplus assigned due to mismatch in the cash flows of the assets versus the liabilities.

It is best, at least initially, to ignore potential variance in the liabilities. Of course, it is expected that the same exercise may be performed viewing the liabilities from both a best estimate, as well as a pessimistic viewpoint. Nevertheless, at the end of this discussion other issues such as variance in liabilities will be addressed.

The sample company used in this paper is a P&C company writing predominately workers compensation. The company is based in California. Information for this presentation was drawn solely from the company's annual statements for the financial year ending 1990.

Selecting assets to meet liabilities

Most U.S. P&C companies have more (in market value) fixed interest securities than is needed to offset the liabilities on an undiscounted basis. Furthermore, the cash flows of these assets are sometimes less than the liabilities at short durations, and extend far beyond the liabilities at long durations. On average, P&C companies are invested at a duration of 10 years, while liabilities have an average duration of 5 to 7 years. An investment strategy of longer duration than the liabilities, serves well in periods where interest rates are reducing, though is not good when interest rates are increasing.

Separation of the fixed interest securities into those assigned to meet the predicted liabilities is very difficult. More so because asset cash flows extend far beyond the liabilities. Three possible methods are described here to select the assets underlying the liabilities:

- Take an average of the fixed interest securities.
  In this method, the whole fixed interest portfolio is converted to cash flows, and the ratio of that portfolio which would exactly offset the liabilities is determined. Those assets assigned to the liabilities, would then be that ratio of every fixed interest investment. This method allocates a fixed percentage of each asset cash

flow at each duration. Consequently, in our sample company, selected asset cash flows at early durations are insufficient to offset the liability cash flows. This would generally be true of the average P&C company.

- Select those assets which provide cash flows closest to the predicted liability flows.
  While this method would be extremely complex, it would be a preferred method as the assets would more appropriately relate to the liabilities, and interest rate risk would be minimized. In practice, a company would likely manually select assets for this purpose.

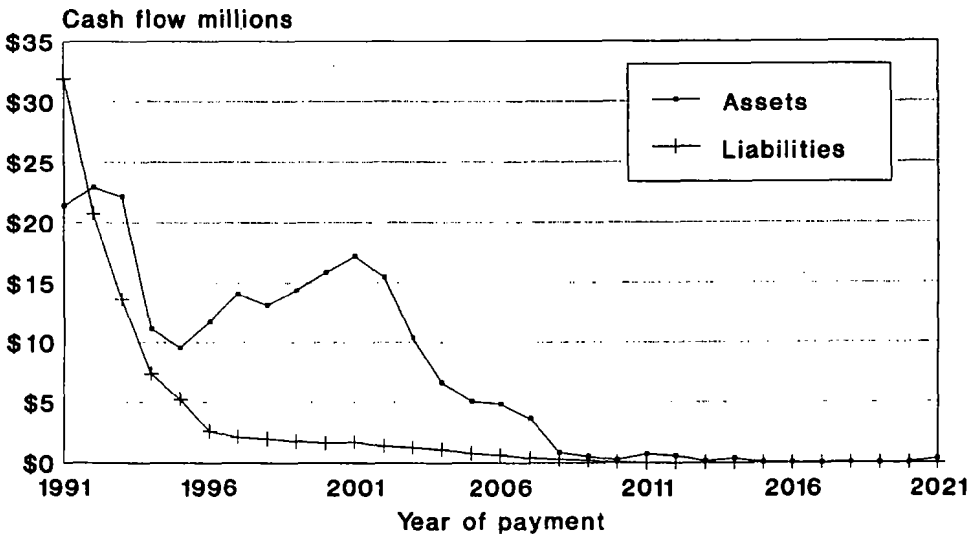
- Select cash flow payments and therefore assign some of the cash flow from each asset to the predicted liability cash flow.
  This method may serve the purpose of providing sufficient asset cash flow to offset the liability cash flow. However, it becomes exceedingly complex if not impossible to determine the market values of the separated parts of each asset.

Clearly the first method is easiest, and the last the most difficult. In this paper, the practical example uses the first method.

A corollary to the selection of assets to offset liabilities, is that the remaining assets would be deemed to be surplus. Consequently, the asset cash flow of surplus funds would be dependent upon the method used for selecting assets to offset liabilities. A discussion is presented at the end of this paper concerning the investment strategy of surplus assets.

The graph below illustrates the cash flow of all fixed interest and cash assets compared with that from the liabilities for the sample company. Interest payments are assumed to take place annually. Liability cash flow has been estimated from schedule P of the NAIC annual statement blank.

Sample Insurance Company
Comparison of asset/liability cash flows



In order to select the portion of asset cash flow which is sufficient to mitigate the liability cash flow, a technique of offset is used. Offset compares asset and liability cash flows and initially the difference of the cash flows is determined. These differences are then accumulated with a low rate of interest if the accumulation is positive, and a high rate of interest if negative. Consequently, these reinvestment assumptions are conservative. For the purposes of this exercise, the reinvestment rate is assumed to be 5%, and the borrowing rate to be 11%. Sensitivity to these assumptions are shown at the end of this paper.

Exhibit A demonstrates the results from using this technique and shows that 61.2% of the cash and fixed interest assets would exactly offset the liability cash flow using the above reinvestment assumptions.

The market value of this portion of the company assets at December 31, 1990 was $86.3 million.

Surplus in investment strategy

In order to estimate the amount of surplus which is included in this investment strategy, a benchmark portfolio is needed which meets several criteria:

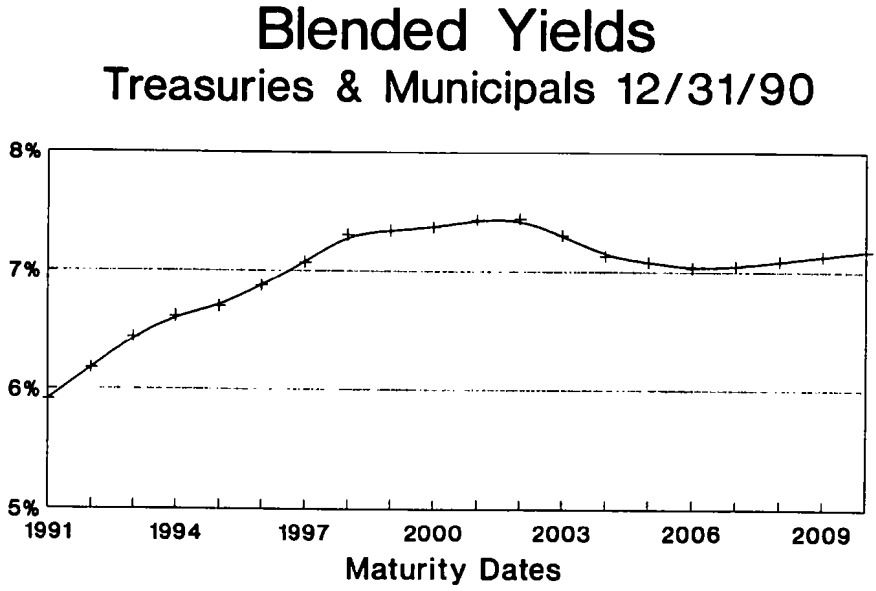
- The portfolio contains investments with the least amount of credit risk (i.e. treasuries).

- Includes allowance for tax versus tax exempt securities. Therefore includes tax exempt municipal bonds.

- Liability cash flow is exactly met by asset cash flow, and therefore, the portfolio is an immunized portfolio and has no reinvestment rate risk.

For the purposes of this paper, treasury and tax exempt municipal bond yield curves have been mixed in proportion to the amount of tax exempts held by the P&C insurance industry. Hypothetical assets were selected from this blended yield curve for the benchmark portfolio. In practice, specific assets should be selected which provide the closest approximation to the liability cash flow. Adjustments and allowances will need to be made for those durations where such assets are not available.

The yield curve at December 31, 1990 for the mix of treasury and tax exempt municipal bonds is shown below.



As this yield curve is in respect of fixed interest assets, developing an immunized portfolio should take into account coupon payments. Exhibit B shows a technique of developing an immunized portfolio assuming bonds are available with all the necessary durations. For simplicity purposes, interest payments are assumed to be equal to the yield rate, and assets mature at par. In reality, actual values will be very different but the method will still follow similar lines to that shown in the example in Exhibit B.

In Exhibit B, the immunized portfolio is obtained by starting with the longest maturing investment first. Once the par value of that investment is known, then the needed par amount of next longest

duration investment can be determined. Par values of each next duration are determined in turn until the shortest duration. The market value can be calculated based upon the par values needed at each duration.

The calculations in Exhibit B demonstrate that a treasury and tax exempt municipal bond portfolio can be purchased at a value of $77.9 million which exactly offsets the predicted liability cash flow. Clearly, this portfolio is virtually free from credit risk, adjusts for a mix of tax and tax exempts, and has no reinvestment or borrowing assumptions. It is, therefore, a suitable frame of reference to evaluate the gains and losses due to mismatch.

Therefore, the amount of surplus used in the investment strategy as a result of the mismatch of asset and liability cash flow is the difference between the assets selected ($86.3 million) and the value of the immunized portfolio ($77.9 million). This is equal to $8.4 million. Of course, if the company is not invested solely in treasury and municipal bonds, an additional amount of surplus is at risk to compensate for the credit risk of the portfolio.

One method to estimate the credit risk cost would be to determine the market value of the treasury/municipal portfolio to offset (cash flows) the company's asset portfolio from Exhibit A. In the sample company, the assets are mostly treasury and municipal bonds, and therefore, the credit risk will be small.

Sample Insurance Company

Selection of portion of assets for liabilities
As at December 31, 1990
Portion of assets = 61.20%
Reinvestment rate = 5%
Borrowing rate = 11%

Year (1)	Asset Cash Flow (2)	Liability Cash Flow (3)	Portion of Asset Cash Flow (4)	Cash Flow Difference (4)-(3) (5)	Accumulated Value of Cash Flow (6)
1991	21,387	31,865	13,088	(18,777)	(20,842)
1992	22,881	20,720	14,003	(6,717)	(30,591)
1993	22,130	13,592	13,543	(49)	(34,010)
1994	11,118	7,348	6,804	(544)	(38,355)
1995	9,566	5,253	5,854	601	(41,906)
1996	11,720	2,575	7,172	4,597	(41,413)
1997	14,053	2,085	8,600	6,515	(38,737)
1998	13,078	1,956	8,003	6,047	(36,285)
1999	14,393	1,740	8,808	7,068	(32,431)
2000	15,884	1,609	9,721	8,112	(26,995)
2001	17,190	1,664	10,520	8,856	(20,134)
2002	15,484	1,349	9,476	8,127	(13,328)
2003	10,344	1,246	6,330	5,084	(9,151)
2004	6,649	1,069	4,069	3,000	(6,827)
2005	5,071	762	3,103	2,341	(4,979)
2006	4,827	600	2,954	2,354	(2,914)
2007	3,628	372	2,220	1,848	(1,183)
2008	813	249	498	249	(1,037)
2009	498	175	305	130	(1,007)
2010	222	64	136	72	(1,038)
2011	707		433	433	(672)
2012	544		333	333	(376)
2013	127		78	78	(332)
2014	357		219	219	(126)
2015	9		6	6	(133)
2016	9		6	6	(142)
2017	9		6	6	(151)
2018	9		6	6	(162)
2019	9		6	6	(173)
2020	9		6	6	(186)
2021	305		186	186	(0)

Clearly, it would be a very narrow viewpoint to determine the surplus due to mismatch based solely upon a single prediction of the liabilities and their associated payout. To understand the dynamics of the investment strategy a company should produce these analyses on both a selected as well as a conservative posture of the liabilities.

Most P&C insurance company fixed interest investments have far more than sufficient cash flows to offset the predicted liability cash flow. Clearly, this type of investment strategy is done to protect the company from adverse development of the liabilities. Furthermore, as assets are generally of longer duration than the liabilities, it would seem that the general consensus is that either this is a suitable investment strategy for greater gain, or that liability deterioration will create additional liabilities payable in the future.

If, however, the liabilities are exactly as predicted, then the company has surplus funds invested at long durations. Such an investment strategy would be suitable if interest rates were expected to fall.

Resulting from the comparisons indicated above, companies can measure the amount of surplus risked due to mismatch. Furthermore, it is possible to make estimates of the amount of investment gains and losses achieved by such mismatch. These statistics will provide

a better framework for companies to assess the advantages and disadvantages of holding assets with distinctly different cash flows to the liabilities.

In Exhibit A the proportion of the market value of the selected assets is partly dependent upon the reinvestment/borrowing assumption. The table below indicates the sensitivity to those assumptions:

Reinvestment Rate	Borrowing Rate	Market Value Change
6%	10%	($2.2 million)
7%	9%	($4.4 million)
4%	10%	($2.2 million)

In this particular example, as the accumulated cash flow is always negative until the end, the market value change is only sensitive to the borrowing rate. Using 5% reinvestment and 11% borrowing, 61.2% of the company's fixed interest assets were needed to offset the liabilities. The table above demonstrates that with borrowing rates of 9% and 10% only 58.1% and 59.6%, respectively, of the company's fixed interest assets were needed to offset the liabilities. This would reduce the estimated surplus in the investment strategy due to mismatch to $4 million and $6.2 million respectively.

Sample Insurance Company

Development of immunized portfolio

Market Value as at December 31, 1990

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Liability Cash Flow	31,865	20,720	13,592	7,348	5,253	2,575	2,085	1,956	1,740	1,609	1,664	1,349	1,246	1,069	762	600	372	249	175	64

Maturity	Blended Yield	Market Value	Distributed asset cash flow to meet liability flow																		
20	7.18%	60	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	64
19	7.13%	159	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	170
18	7.09%	217	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	233	
17	7.05%	318	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	341		
16	7.03%	511	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	547			
15	7.08%	628	44	44	44	44	44	44	44	44	44	44	44	44	44	44	672				
14	7.13%	873	62	62	62	62	62	62	62	62	62	62	62	62	62	935					
13	7.31%	979	72	72	72	72	72	72	72	72	72	72	72	72	1,050						
12	7.44%	1,007	75	75	75	75	75	75	75	75	75	75	75	1,082							
11	7.43%	1,230	91	91	91	91	91	91	91	91	91	91	1,322								
10	7.37%	1,095	81	81	81	81	81	81	81	81	81	1,175									
9	7.34%	1,142	84	84	84	84	84	84	84	84	1,226										
8	7.31%	1,265	92	92	92	92	92	92	92	1,358											
7	7.07%	1,302	92	92	92	92	92	92	1,395												
6	6.87%	1,677	115	115	115	115	115	1,792													
5	6.70%	4,081	273	273	273	273	4,355														
4	6.61%	5,794	383	383	383	6,177															
3	6.44%	11,310	728	728	12,038																
2	6.18%	17,365	1,072	18,438																	
1	5.91%	26,918	28,510																		
		$77,931																			