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Defined Benefit Plans are More Successful with Bonds

by Mark Ruloff

Recent meetings on financial economics have promoted the idea of an all-bond asset allocation. Financial economics calls us to take a corporate-centric, rather than plan-centric approach to pension asset allocation selection. This promotes tax and other advantages of an all-bond asset allocation. Also, "On the Risk of Stocks in the Long Run," by Zvi Bodie, demonstrated by the cost of shortfall insurance (a put on the pension portfolio with a strike price equal to full funded liability), that stocks are actually more risky in the long term. However, we can also learn about the risk of investing in stocks by using some traditional actuarial tools, like measuring the "probability of ruin."

It is commonly known that actuarial liabilities and normal costs are lower using a discount rate based on higher equity returns as compared to lower bond returns. However, if we factor in the probability of ruin (which we learned during our actuarial exams, but rarely use with pension trust funds), we will find that a plan than avoids ruin costs less with a large bond asset allocation and uses lower expected rate of return assumptions.

Cost Without Reflecting Risk

I took a sample plan that I commonly use and did some traditional pension actuarial calculations assuming two asset allocations, a 60 percent large cap stock and 40 percent long-term corporate bond portfolio and a 100 percent long-term corporate bond portfolio (the bonds were not chosen to exactly match the liability duration). I worked with a public plan in order to avoid all the ERISA funding constraints. Based on historical returns of 10.42 percent for stocks and 5.69 percent for bonds, I assumed an 8.61 percent return for my 60/40 asset mix and a 5.69 percent return for my 100 percent bond asset mix. Not surprisingly, the traditional entry age normal costs of the plan were less under the 60/40 portfolio than under an all-bond portfolio. The resulting entry age normal costs as a level percent of pay (rounded up to the nearest 50bps) were 4.5 percent and 8.5 percent, respectively.

The Price of Risk is Ruin

While "ruin" in the insurance business is commonly defined as not having enough assets to cover liabilities, this test would probably be considered too strict in the current pension environment. Therefore, I will not define ruin at such a level even though I think it is a worthy goal. Instead, I will define ruin as not having enough assets to make the upcoming years' benefit payments.

There are two primary issues that can cause ruin. One would be an issue directly related to the plan that would cause the plan sponsor to terminate the plan. The other would be an issue directly related to the plan sponsor, but outside of the plan, that would cause the termination of the plan. I decided to only study the first case here.

To test the possibility of ruin, I ran a 100-year stochastic forecast with 1,000 trials. I set the starting assets of my plans at the value of the entry age normal liabilities and set the contribution policy to the cost as a percentage of pay levels mentioned above. My capital market assumptions factored in the 20.44 percent standard deviation of the stock return and 8.61 percent standard deviation of bond return; again these were based on historical information. The standard deviation for the 60/40 allocation was 13.49 percent. I assumed a level population with new hires replacing active employees who decrement and included a 3 percent growth in the active population. However, I made no adjustment to the contribution rate to reflect a possible higher cost level for new hires. Table 1 on page 6 shows the number of times ruin occurred out of the 1,000 trials in 10-year increments of the forecast.

Although only one of the 1,000 bond trials with higher contributions faced ruin in the 100-year forecast, over 56 percent of the 60/40 allocation trials with lower contributions did. While the only ruin for the all-bond allocation, occurred in the 99th year, the ruins for the 60/40 allocation occurred as early as 20 years. Obviously, if one wanted to have a defined benefit plan that would survive rather than face ruin, the 8.5 percent of pay contribution and all-bond allocation is a better option.

A first thought might be that we could avoid these cases of ruin by adjusting the contribution level, as is commonly done in practice. However, the resulting necessary extremely large contribution levels would also cause the employer to want to terminate the plan. For example, the plan sponsor might be willing to vary the contribution to be normal cost plus 10-year amortization of the unfunded liability but only as long as the contribution level stayed below 15 percent of pay. Using that as the new definition of ruin, over 61 percent of the 60/40 asset allocation trials hit ruin over the forecast.

Although the method used above for determining contribution levels may be the actual way contributions are determined, this may not produce a good scientific test. There are several moving variables: the contribution rate, the starting asset value and the asset allocation. A better scientific test on the asset allocation is to keep the contribution rate and the starting asset value constant and just move the asset allocation. Therefore, I set the contribution rate to 8.5 percent, used the larger starting asset value and tested both of these allocations again. I also considered a 100 percent stock allocation for good measure. The results are shown in Table 2.

(continued on page 6)

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Table 1: Number of "Ruins" in 1,000 Trials										
Year	10	20	30	40	50	60	70	80	90	100
8.5% of pay contributions										
All bonds	0	0	0	0	0	0	0	0	0	1
4.5% of pay contributions										
60/40	0	1	46	199	322	379	437	483	529	561

Table 2: Number of "Ruins" in 1,000 Trials										
Year	10	20	30	40	50	60	70	80	90	100
8.5% of pay contributions										
All stock	0	0	3	8	10	12	12	12	13	14
All bonds	0	0	0	0	0	0	0	0	0	1
60/40	0	0	0	2	5	6	7	7	7	9

Even with the same larger contribution level, the allocations to stocks caused more ruins than the all-bond allocation.

To complete this, I decided to test what the contribution level would need to be to have only one ruin in the 100-year forecast with the 60/40 allocation. The resulting contribution level was between 9.5 percent and 10 percent.

Not Reflecting Risk in Cost is the Root of the Problem

As we can see from the figures mentioned earlier, the largest part (98 percent, (561-9)/561) of the causes of "ruin" is the calculation of the lower funding level, as it does not reflect risk. This issue is also the source of why some individuals erroneously conclude that a large asset allocation to stocks is the low-risk investment for pension plans. Once an insufficient contribution level has been determined, studies of the optimal low-risk investment are flawed. These studies, which use insufficient funding levels, will not show the low-risk asset allocation but instead will seek out an asset allocation that attempts to compensate for the insufficient funding. More risk will be taken in the asset allocation to reach for higher returns. We could find that the best chance to accumulate a million dollars for retirement when saving only a dollar a year is to buy lottery tickets. However, we should not consider lottery tickets the low-risk investment and there are probably other less risky savings and investment options.

These common studies may also show only a few cases of "ruin" over short periods like 10 years or less. However, a significant amount of "ruins" will appear over longer forecasts, especially in 100-year forecasts, as more will have a long bear market during the forecast. This risk may appear to be thought of as small, showing up as low as the worst one percentile. However, in a 100-year forecast, one percentile events may really imply that every trial reached "ruin." Therefore, it is important to look at individual trial results. I believe if you study this carefully you will find that the question is not so much *if* ruin will occur but *when.*

We should also note that a bear market is not something that we could insure against on the same basis as having a house insured against fire. The law of large numbers applies to insuring against a house fire, as each event is generally independent of another. However, having a bear market attack a pension plan is not independent from a bear market attacking another pension plan. Therefore, when plans reach this point, there may be mass termination of plans. This should to be considered by the PBGC when trying to insure pension plan benefits.

Choice Reflecting Risk

Looking back at our testing of the probability of ruin, our choices seem to be:

- Large stock allocations with apparent lower contributions, but with periods of defined benefit plans going into ruin;
- Large bond allocations (or other low-risk options) with stable higher contributions and solvent plans
- Large stock allocations with even higher contributions (but still with periods of underfunding on a termination basis).

In conclusion, current funding, accounting and "ongoing" liability measures promote the use of stocks by reflecting the increased returns, but not the risk. The resulting inadequate funding forces investment managers into large allocations to stocks in an attempt to compensate for the lower funding. Ultimately, this leads to more cases of "ruin." When fully reflecting the risk, we discover that solvency and stable sufficient contributions are best achieved with a large allocation to bonds and by using rate of return assumption that does not consider an equity risk premium (without the risk). ◆

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