



Valuation and Risk of DB Plan Sponsor Guarantees

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Main Points for Today

- Every defined benefit pension scheme has an explicit guarantee of funding from the sponsoring organization
 - If the plan becomes underfunded by virtue of poor investment results, the sponsoring entity must increase cash contributions in future years to make up the shortfall
- One conceptual way to view this situation is to assume that a pension plan is always fully funded
 - Any underfunding is made up by an implicit asset which is similar to a perpetual call option on a bond from the sponsor
 - Alternatively, the fund has a put option on the fund surplus. The sponsor is short that put
 - Under this framework, both the asset allocation and risk profile of a underfunded pension scheme is quite different from the conventional perspective, as a large portion of the fund is now concentrated in a bond-like security of a single issuer.
- Actuarial and accounting standards (e.g. FASB 87) have key differences across countries and between corporate and public sponsor entities

Ownership and Economic Incentives

- The key question with respect to any defined benefit pension scheme is to whom does the money in the plan belong?
 - The obvious answer is the pensioners but it's not that simple
- The sponsoring entity is responsible for shortfalls so they have an economic stake in investment performance
 - The better the investment performance the lower the expense of future contributions will be
 - This is good for shareholders, existing employees and tax payers (public funds)
 - If the plan ends the sponsor may be able to recapture surplus
- The pensioners only concern about investment performance is that it not be so horrible that the sponsor is strained to the point of default on funding obligations
 - Not much upside

Pension Liabilities in Brief

- Accumulated Benefit Obligation
 - The present value of promised pension benefits assuming the plan was terminated immediately
- Pension Benefit Obligation
 - The present value of promised pension benefits assuming the plan is ongoing and staff continue to receive pay increases until normal retirement
- The promised pensioner payments included in ABO and PBO are discounted to present value
 - In most countries the discount rate is the assumed rate of return on investment for the plan assets
- Corporate plans in some countries follow FASB 87
 - Specifies that the yield on high quality corporate bonds be used and is subject to periodic reset
 - Multiple discount rates conforming to an observable yield curve are rarely used

A Simplistic View

- Running a defined benefit pension scheme is just being long a diverse set of assets (equities, diverse fixed interest, property) and being short a portfolio of risk-free fixed interest securities

If the plan is supposed to be riskless to the pensioners, why not discount the liabilities at risk free yields?

 - We assume that the sponsor will continue to exist to act as a guarantor of the benefit payments through additional contributions if needed
 - Discounting at the *expected* return on assets makes volatility of annual contributions smaller which is helpful for corporate operational planning
 - This fine as long as the amount of additional benefit payments potentially required are not too large for the sponsor to handle
- Secondary guarantors may also exist
 - In the UK there are private pension insurers (e.g. Brighton Rock)
 - For US corporate plans there is the PBGC (80% coverage)

Status of Defined Benefit Plan Funding

- Most corporate plans subject to FASB 87 are in OK shape
 - Oddly, the big risk for these plans is if credit market conditions improve. Government bond yields in many countries are close to all time low values.
 - If credit spreads decline, corporate bond yields will also drop resulting in a decrease in the pension liability discount rate which will increase the present value of the liabilities
- Public entity pension plans are another story
 - In the US, the aggregate underfunding of state and local pension schemes is acknowledged to be over \$1 TRILLION
 - If you put US public funds on the corporate accounting standard, the underfunding is estimated at over \$2.5 TRILLION
 - Many large European funds (e.g. ABP) are in good condition
 - A few countries such as Canada have partially funded schemes
 - Countries such as Greece have borrowed heavily to deal with pension related budget deficits on “pay as you go” plans

The Meaning of a “Fully Funded” Plan

- Many people assume that if a plan is in “fully funded” status it will not require unexpected additional contributions from the sponsor
 - For most plans where the liability discount rate is the expected rate of return on assets, there is a 50% chance that the realized investment returns will be less than assumed, so there is a 50% probability that additional funding of some size will be needed
 - For FASB 87 compliant plans, the probability of needing additional sponsor funding is less but can still be substantial depending on the volatility of the asset portfolio, the volatility of bond yields and the duration of the liability payment streams
- For underfunded plans, the dependence on additional contributions from the sponsor is obvious
 - Under FASB 87 the sponsoring firm shows pension scheme underfunding as a liability on the corporate balance sheet
 - FASB 106 does the same for health care costs

An Alternative View of Pension Funding

- Every defined benefit pension scheme has sufficient asset value at all times such that the probability of not meeting a required payment is nil
- A significant part of the asset portfolio is an implicit asset which is a portfolio of call options on bonds (i.e. a fixed stream of cash flows) from the sponsoring entity
 - The value of this implicit asset is not only large enough to bring the plan to full funding, but is large enough to bring the plan to a sufficient surplus as to virtually guarantee all obligations
 - Even for a fully funded plan, the notional exposure is real
 - If a plan was really funded to this level of surplus, it would be subject to tax penalties in some countries (e.g. USA)

More Alternate Views

- Under this framework, the typical pension asset portfolio is quite different than in the conventional view
 - Since the implicit asset is a call option on securities of a single issuer, the degree of issuer specific risk is often very large
 - The asset allocation is shifted radically away from equities toward fixed income
- As previous noted, you can also think of the situation as the fund having a put option on the fund assets with a strike price of the liabilities.
 - The “call option on a bond” formulation seems more realistic because the required pension inflows would be scheduled out on a roughly level basis, much like the coupon stream of a bond

A Rough Example

- We have a “fully funded” pension scheme
 - 50% in the FTSE All World Index in US\$,
 - 50% in FTSE 15+ Maturity UK Gilt Index
 - Expected returns are 9% and 7% respectively
 - Historic volatilities are 15.88% and 11.34% respectively
 - Historic correlation is .18
 - Liabilities are level payments for 25 years
- Portfolio expected return is 8% with a volatility of 10.55%
 - We know the likelihood of realizing 8% is 50%
 - To get a 99% chance of meeting our return target over a 25 year horizon, we have to go all the way down to 3%
- If we discounted our liabilities at 3% instead of 8%, we would be far below full funding.
 - We need to have a 62.27% surplus that is the difference is the value of the implicit call option on additional funding from the sponsor

Rough Example II

- To reduce the likelihood of needing additional funding from the sponsor to below 1% we need a 62.27% surplus
 - Our portfolio now consists of 50 units of FTSE equity, 50 units of FTSE fixed income (gilts) and 62.27 units of value in the implied call option on a bond from the sponsor
- Our asset allocation has shifted to 30.8% equity, 30.8% conventional fixed income and 38.4% implicit fixed income.
- Is it prudent to put 38.4% of a large pension scheme into a call option on the bonds of a single issuer?

Rough Example III

- By having the equivalent of 62.2% of our current portfolio value in the implicit asset we are taking on some specific risk
- Let's assume that our plan sponsor is Ford
 - Our estimate of specific variance for the average Ford bond is 19.5%²
 - The additional variance added to the portfolio is about 7.5 units.
 - Our portfolio volatility increases by a modest amount from 10.55% to 10.89%
 - The increased volatility is equivalent to a 4 basis point decrease in the compound annual growth rate, and a 12 basis point decrease in investor utility (risk adjusted return)
 - *There are also factor risks embedded in the corporate default risk that will change the factor exposure of the asset portfolio.*
- For a fully funded plan with a creditworthy issuer, the increase in risk to the pension portfolio seems small but is enough to meaningfully impact the plan

How about an underfunded plan?

- Let's consider the same case but with the plan only 70% funded
 - We still need to have a 62% surplus given the volatility of the portfolio and our capital market expectations
 - Our implicit asset now makes up the difference between 70% funding and 162% funding.
 - The additional specific risk is now 16.5 units
 - Our portfolio volatility estimate has increased to 11.58%
 - The equivalent loss of compound growth rate is now 11 basis points and the loss of investor utility is around 40 basis points per annum
- For underfunded plans the increased risk associated with the specific risk of sponsor guarantees is definitely material

How about a more aggressive fund?

- Let's assume we started with a 70% allocation to equities and a 30% allocation to fixed income
 - The expected return for the fund is now up to 8.40%
 - The volatility of the fund is up to 12.19%
 - With the higher expected return, our plan is now about 103% funded
- As both the mean and standard deviation of the return distribution have increased, the tail probabilities don't change very much
 - Over the 25 year horizon, we still need to have a discount rate down around 3% per annum to make the probability of requiring sponsor funding less than 1%
- This suggests that sponsors cannot substantially reduce the economic value of the implicit guarantees by taking a more aggressive investment posture to increase the expected returns

A Discretionary Wealth Approach

- Another way to think about this issue was provided by Wilcox (2003)
 - The optimal value for an investor's mean variance risk aversion (aka lambda) is related to the ratio of total assets to surplus (assets minus liabilities)
 - The optimal value for lambda is $L/2$ where L is the ratio of total assets to surplus
If we believe our asset allocation is mean variance efficient we can calculate the tangency slope as lambda
- Once we have lambda we can use the Wilcox formulation to solve for the percentage of surplus required to justify the lambda value
- The difference between the current funding ratio and the ratio with the required surplus is the value of the guarantee
 - Results are consistent with the previous example

Assessing Corporate Default Risk

- Our approach to the credit risk of a corporate bond is to decompose the corporate bond into a riskless bond and equity of the issuer
 - Use a combination of equity risk models and “contingent claims” structural credit risk methods as in Merton (1974)
 - diBartolomeo (2010)
- The *approximate portion* of a corporate bond’s value that is allocated to equity is:

$$(-(T-B)/B) * (\Delta_p / \Delta_c)$$

- T = the value of the bond if it were riskless
- B = the market value of the bond
- Δ_p = the delta of the shareholder put option
- Δ_c = the delta of the shareholder call option

Corporate Sponsor Default Risk

- If a corporate plan sponsor has traded bonds we can use the allocation method to describe two key attributes, Probability of Default (PD) and Loss Given Default (LGD)
 - The expected loss of value given default (LGD) is simply the portion of the value of the obligation that is allocated to equity in the issuing firm
 - Given the yield on the traded bonds of the firm, we can estimate an “option-adjusted spread” (OAS), the portion of a bond’s yield that is attributed to credit risk
- If we have both LGD and OAS, we can estimate the probability of default (PD) either assuming risk-neutrality or any particular level of risk aversion
 - Again we can invoke the DWH on bond data to estimate a reasonable risk aversion

Sovereign Sponsor Default Risk

- “Pay as you go” plans are normally prevented from defaulting by new taxes or currency devaluation

The difference between the current Eurozone crisis and the Russian currency devaluation in 1998

- The old age pensions of Russian citizens were essentially wiped out through a large currency devaluation
 - The current Eurozone crisis over Greek sovereign debt is unresolved
- We are currently working on an approach to sovereign debt similar to our approach to corporate debt
 - Bodie, Gray and Merton (2007)
 - See Emilian Belev’s presentation at this event
 - Estimate the total assets of a country as the present value of projected GDP (like a dividend discount model)
 - National debt includes issued debt, aggregate unfunded pension liability and a reserve for bank “bailouts”

Developed Country Sovereign Risks

- If there was one lesson that should be learned in the financial crisis it was that “too big to fail is real”
- The financial stability of national governments and the stability of the banking system is inextricably linked
 - We've modeled government securities are part of the “financial sector” since 1999
- The US is low on the scale of bank vulnerability
 - The “systemic risk banks” in the US have assets of 65% of GDP
 - France 249%, UK 337%, Switzerland 550%, DB alone is 84% i
 - My stunning day in 2008
- Unfunded pensions are clearly big in the US as previous noted and in the UK according to press reports

Conclusions

- The guarantee of additional funding if required is a key ingredient to every defined benefit pension scheme.
- Many pension funds around the world are substantially underfunded to an aggregate of many trillions of dollars
- Conventional views of fund asset allocation and fund risk levels ignore the economic value of the funding guarantee
- We prefer to formulate the problem as having all funds funded to an appropriate level of surplus at all times, with the an implicit asset that is a call option on a bond of the sponsoring firm.
- For typical pension funds, the degree of implicit surplus required is material to asset allocation decisions and fund risk assessments

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