Economic and Financial Approaches to Valuing Pension Liabilities

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Abstract

Financial economics holds that payment streams should be valued using discount rates that reflect the cash flows' risks. In the case of pension liabilities, the appropriate discount rate for a pension fund's liabilities is the expected rate of return on a portfolio that would be held under a liability-driven investment policy. The valuation of defined benefit (DB) pension obligations involves choices revolving around deciding 1) what future benefit payments to recognize today (i.e., which liability concept to use); and 2) from whose point of view to value the liabilities. Moving towards modeling the distribution of future liabilities using a "risk-neutral" framework would allow for calculating the present value of the future liabilities more accurately. This would provide policymakers with information more relevant for decisionmaking, and it would also permit easier communication of the risks facing the Pension Benefit Guaranty Corporation's PIMS model via a single univariate statistic.

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> *Price is expected discounted payoff.* This fundamental relation underlies all of asset pricing. The discount factor is an index of "bad times." Because investors are willing to pay more for assets that do well in bad times, the risk premium on any asset is determined by how it co-varies with the discount factor. All of asset pricing comes down to techniques for measuring a discount factor in a way that is useful for specific application.
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> — Cochrane and Culp, in Modern Risk Management

Payment streams should be valued using discount rates that reflect the cash flows' risks. This bedrock principle of financial economics goes back at least to the development of the capital asset pricing model (CAPM) in the 1960s (Treynor 1961; Sharpe 1964; Lintner 1965). The standard modern application involves discounting cash flows at rates that depend on the cash flows' covariance with multiple priced risks (Ross 1976; Fama and French 1993). In the case of pension liabilities this may be interpreted concretely, as saying that the appropriate discount rate for a pension fund's liabilities is the expected rate of return on an optimal "hedge portfolio," where this is the portfolio that would be held under a liability-driven investment policy (i.e., the portfolio of traded assets that has cash flows that most closely approximates the funds expected future benefit payments).

While the basic methodology for valuing liabilities payments is well understood, its application to the valuation of defined benefit (DB) pension obligations involves choices that are

context-specific and which have a material impact on the calculation. The choices primarily revolve around deciding 1) what future benefit payments to recognize today (i.e., which liability concept to use); and 2) from whose point of view to value the liabilities.

Liability Concept

DB pensions are a form of delayed compensation. For work performed today, employees receive, in addition to their wages, promises of benefits to be paid after retirement. In order to value these benefits, one must first decide what expected future benefits should be recognized today. The broadest concept, the present value of benefits (PVB), recognizes all future expected benefit payments. This is analogous to accounting for the net present value of all of an employee's expected future wages as a current liability, something that seems unreasonably broad for most applications. The public sector commonly recognizes pension liabilities using a concept called the pension benefit obligation (PBO), or a closely related methodology called the entry age normal (EAN). These account for future wage growth but not future service, and thus they recognize only a fraction of the PVB. The PBO recognizes the PVB in proportion to the fraction of an employee's service earned to date, relative to the expected total at retirement. The EAN recognizes the PVB in proportion to the fraction of an employee's discounted total wages earned to date relative to the expected total at retirement. The narrowest commonly used liability concept for DB pension plans is the accrued benefit obligation (ABO). This concept only recognizes the benefit payments that have been earned to date, and bases projected benefit payments off of an employee's current wage history. It corresponds quite closely to the benefits that a worker would receive if the plan to which they belonged was shut down today, and is thus often called the "termination liability."

Broad measures of pension liabilities that account for wage growth (e.g., the PBO, EAN, or PVB) need to be discounted at higher rates. Wages are exposed to priced risks. Wage growth, the stock market, and the economy more broadly, must all be positively correlated, at least over longer horizons. According to Black (1989), "stocks go up when it looks like times will be good. In good times, wages and salaries and benefits all tend to grow faster than usual. Thus the broader your view of the pension liability, the more stocks you will need for hedging." Lucas and Zeldes (2006) develop a framework for estimating appropriate risk-adjusted discount rates for DB pension liabilities, which account for future pension benefit payments' exposure to the market through the wage growth channel. These issues are less relevant for the ABO, which is not exposed to wage risk, and the ABO is the most relevant liability concept for the Pension Benefit Guaranty Corporation (PBGC).

Bulow (1982) argues that the is ABO is the appropriate liability concept for corporate plans quite generally, because broader concepts unreasonably imply an "implicit contract under which young workers accept lower total compensation in return for an informal agreement that they be highly paid later in their career." This has implications beyond those directly related to exactly which benefits are currently recognized. Bulow (1982) suggests that an "example of the effect of such an assumption is that many mistakenly believe that if a worker's benefits are tied to final salary, he is protected against inflation until retirement." The existence (or lack thereof) of inflation protection impacts the appropriate discount rate to use for discounting liabilities, regardless of which exact liabilities are recognized. Bodie (1990) suggests that the "failure of pension funds to show any significant interest in inflation-protected investment products such as CPI-linked bonds is clear evidence that they [the plan sponsors] do not view their liabilities as indexed for inflation."

Most importantly, under U.S. law, the PBGC's guarantee only extends to benefits accrued prior to a firm's bankruptcy filing. New (insured) accruals thus stop in plan terminations, or even before if bankruptcy predates a plan's termination. The PBGC's liability consequently only extends to the ABO liabilities, making it the most relevant liability concept when valuing DB pension liabilities for PBGC insurance purposes[1].

Valuation: Promises, or Expected Payments?

The value of the same pension promises may not be the same from the point of view of different stake-holders. For example, retired participants of a plan administrated by a firm near bankruptcy may value their claims under the assumption that they are relatively safe, at least partly because of the existence of the PBGC insurance. These same expected benefit payments may be valued much lower by the firms' stockholders, who have limited liability. Valuation of DB pension liabilities thus requires a decision, either explicit or implicit, about exactly which payments are being valued. This is basically a question of whether the payments being valued are the promised payments, or the payments that are actually expected to be made.

For the last decade, the Employee Retirement Income Security Act (ERISA) has required private sector firms to discount expected pension payments for reporting and funding purposes using corporate bond rates[2]. These prescribed discount rates implicitly value pension liabilities from the point of view of a firm's equity holders. Corporate bond rates reflect the possibility that

[1] Broader concepts may be more appropriate in the public sector, where future benefit accruals often have statutory protections.

[2] For the previous 25 years, ERISA prescribed even lower discount rates, the 30-year Treasury yield.

firms may default on their debts. These rates thus account for fact that expected payments are smaller than promised payments (because of the possibility of default). They also include a risk premium that arises because defaults co-vary with priced risks (i.e., because defaults are more likely in bad times, when extra dollars are particularly valuable). ERISA thus prescribes that firm managers value the pension payments that the plan sponsor expects to actually make, not the payments the plan participants expect to receive[3].

The distinction arises from limited liability, and from the value of PBGC insurance itself. From the point of view of plan participants, PBGC insurance is a valuable asset. The insurance makes the future benefit payments (up to a limit) almost risk-free, and thus the stream of payments retirees expect to receive more valuable. From the point of view of the plan sponsor, PBGC insurance is less valuable, because in the event the insurance pays off, it is the participants, and not the sponsor, that receives the payments[4]. For the sponsor, limited liability essentially acts as a valuable put option, which reduces the value of the stream of benefits it promises. Under certain conditions, a sponsor's liability is limited to the value of a plan's assets, which is economically equivalent to owning an option to deliver the plan's assets in exchange for the value of the plan's liabilities.

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[3] Technically these are valued as if other similar firms were responsible for the payments, because the ERISA-specified rate is not the firm-specific borrowing rate, but a high grade corporate index rate.

[4] PBGC insurance is not without value to the sponsor, because firms negotiate with employees over total compensation. PBGC insurance, which increases the value of pension benefits to workers, may thus reduce the direct wage compensation an employer must promise.

Conceptualizing the value of PBGC insurance as a put option allows for its valuation using the no-arbitrage techniques developed to price options (Black and Scholes 1973)[5]. The standard methodology for pricing derivative securities involves constructing the instrument's replicating portfolio (the "synthetic" security), which generates the exact same cash flows at every date in the future in every possible future. Market forces ensure that the price of the derivative security must be close to the price of the hedge portfolio.

A number of authors have used this framework to analyze the value of PBGC insurance (e.g., Marcus 1987 and Pennacchi and Lewis 1994), and particularly the moral hazard arising from the very existence of PBGC insurance. Bodie (1990) suggests that for underfunded plans "… it may be optimal to exploit the put provided by PBGC insurance through a high-risk investment strategy."

Insured Liability

ERISA (and later the Pension Protection Act of 2006) prescribe that firms account for their pension liabilities using rates that implicitly reflect the possibility of default, yet these rates may not be appropriate for valuing the PBGC's liabilities. The PBGC exists to guarantee pension benefits. Because it will make payments that a plan sponsor cannot, it is inappropriate to use discount rates that reflect the possibility of the sponsor's default when calculating the PBGC's potential liabilities.

The fact that the PBGC's potential liability extends only to ABO benefits (subject to the payment cap), in conjunction with the fact that benefits paid by the PBGC are essentially risk-

[5] These techniques can themselves be viewed as a particularly powerful application of the basic principle that cash flows should be discounted at rates that reflect their risks.

free, make the valuation of these liabilities relatively straightforward. The ABO is not affected by uncertainty about future wages and service, as the cash flows associated with the ABO are based completely on information known today (plan benefit formulas, current salaries, and current years of service). Mortality is relatively easy to forecast (probabilistically), and the uncertainty in these forecasts is largely idiosyncratic (i.e., uncorrelated with aggregate economic variables that may be related to discount rates)[6]. Pension *promises* related to termination liabilities, which are insensitive to wage risk, should thus be discounted at riskless rates of return (Sharpe 1976).

This valuation is most concretely done by simply pricing the defeasance portfolio. A plan's liabilities can be defeated (i.e., made null and void) by delivering a portfolio of securities that generate the income required to make all future benefit payments. The cost today of buying this replicating portfolio is the value of the liabilities. The defeasance portfolio can most easily be constructed using either true market annuities or default free bonds.

The advantage of defeasing the liabilities using market annuities is that these already account for the impact of mortality on expected payouts, making the construction of the replicating portfolio particularly simple. Defeasing the liabilities this way yields insurance industry annuity pricing of the liabilities. Such pricing may slightly overstate the true cost of liabilities, because the market for these annuities is not as transparent or competitive as the market for high quality bonds. That is, insurance industry annuity pricing reflects the provider's

[6] Plan experience suggests that the most commonly employed mortality tables have failed to adequately account for generational improvements in mortality. Mortality assumptions are an important driver of projected benefit payments, so this has tended to bias forecast liabilities downward.

profit margins, which are likely higher than those enjoyed by market makers in the bond market.[7] This is likely more than fully offset by the fact the credit quality of the PBGC is superior to that of even the best annuity providers, which means that the value of an annuity provided by these companies is lower than that of a similar annuity provided by the PBGC. The PIMS model also uses annuity prices that come from surveys, not transactions. While the American Academy of Actuaries reports only modest differences (3-5%) between the PBGC's survey prices and actual transaction prices, these differences are magnified in firms' net pension liabilities.[8]

The advantage of defeasing the liabilities using default-free bonds is that this may most accurately reflect the true cost of the liabilities provided by the PBGC. This does require forecasting the effects of mortality on expected payments, but this is relatively simple and straightforward. Because the liabilities are basically nominal (i.e., not inflation protected), the bonds employed in the defeasance calculation should themselves be nominal. Using Treasuries

[7] Insurance companies may also sometimes misprice annuities due to market imperfections. Koijen and Yogo (2013) argue that insurance companies were significantly underpricing annuities in late 2008 and early 2009, because of market losses that hurt their balance sheets, and statutory reserve regulations that allowed them to account for only a fraction of the true future insurance liability.

[8] For example, suppose a firm has $90 of pension assets, and pension liabilities valued at $95 when calculated using annuity prices derived from surveys and $100 when calculated using annuity transaction prices. The firm's net pension underfunding is only $5 when calculated using survey prices but $10 when calculated using transaction prices, a difference of 100%, despite the fact that the survey annuity prices are only 5% lower than the transaction prices.

would almost certainly yield a liability that overstates the liabilities' true value, because Treasuries enjoy a significant liquidity premium (i.e., are expensive) due to their use as a safe-haven asset, and because they have special status as a collateral asset (Longstaff 2004; Krishnamurthy and Vissing-Jorgensen 2012). The true value of the liabilities is thus probably more accurately reflected by the cost of the defeasance portfolio constructed using agency securities, which are close to risk-free but do not enjoy the special status of treasuries.

While there are many subtle issues around the appropriate recognition and valuation of DB pension liabilities, valuing liabilities that the PBGC insures, is ultimately relatively straightforward. By law, the PBGC's liabilities are limited to the ABO. The only risk the insured ABO cash flows are exposed to is mortality risk, which is basically unpriced. These liabilities are thus effectively risk-free, and they should therefore be discounted at risk-free rates. These rates are probably best reflected by the yields on agency securities, which are extremely unlikely to default but do not carry the liquidity premium built into Treasury yields.

Discounting the distribution of expected future liabilities back to a current "value" is much more difficult. The PIMS User Manual explicitly states that the model should only be used to forecast possible outcomes, so it cannot be used to calculate a present value of these future liabilities. In practice, however, users of the model seem unable to refrain from doing so. The headline summary statistic that people use to talk about the funding status of the PBGC comes directly from discounting the expected future liability at risk-free rates, which is completely inappropriate. Moreover, this certainly understates the true magnitude of the PBGC underfunding.

Despite the fact that the evolution of the termination liabilities in the PIMS model is driven largely by the interest rate process, the timing and extent to which the PBGC is forced to

assume these liabilities is driven in large part by market and macroeconomic risks. If the PBGC's underfunding is particularly large in 10 years, it will almost certainly be because the U.S. economy underperformed expectations. This is precisely the time at which any given level of underfunding will be particularly painful, and discounting the models' forecasted distribution of future underfunding fails to account for this reality.

Moving towards modeling the distribution of future liabilities in a manner that accounts for the price of risk (i.e., using a "risk-neutral" framework) would allow for calculating the present value of the future liabilities more accurately. This can be an important step for the PIMS system, as it would provide policymakers with information more relevant for decisionmaking. A proper valuation would account for the possibility of painful "tail events," and do so in a way that appropriately accounts for the pain associated with these relatively low probability events. This would also permit easier communication of the risks facing the agency with a single univariate statistic.

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