PRACTICE NOTE

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LDI for DB plans with lump sum benefit payment options

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ISSUE:

How does a lump sum benefit payment option affect an LDI strategy in a defined benefit (DB) pension plan?

RESPONSE:

A lump sum benefit payment option (not just a temporary window) can have a significant effect on the design of a DB plan's LDI strategy. Expected cash flows are less certain than they are for plans that offer only annuities. In addition, it may be difficult to determine the correct duration of plan liabilities by use of the expected cash flow information provided by the plan actuary alone. Determining duration may require more information (and possibly more liability cash flow calculations) from the plan's actuary than is available in the standard valuation output being produced.

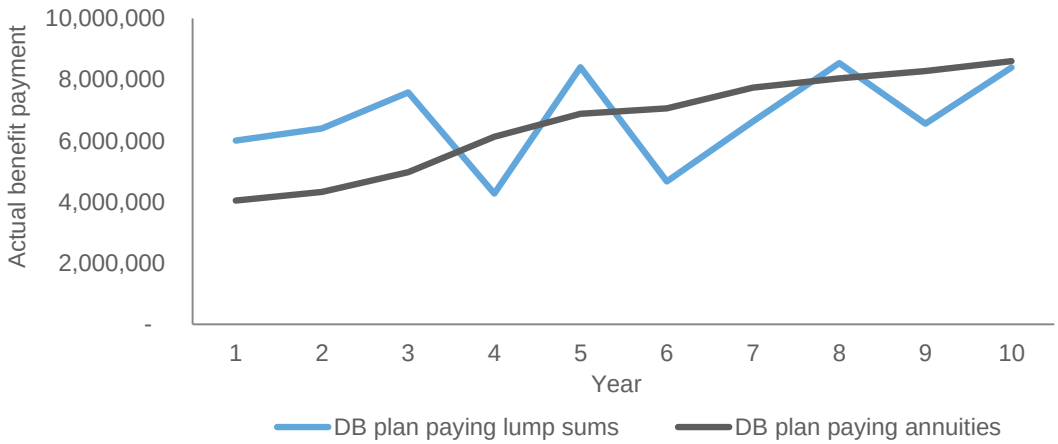
The LDI manager needs to understand what assumptions and methods the actuary used to calculate the projected cash flows. Becoming familiar with the form of payment, actuarial equivalence and mortality assumptions is particularly important, to ensure that the LDI strategy is aligned to the appropriate hedging target.

Given the interest rate risk most DB plans carry (even those that offer lump sums), LDI is still a great option, but plan sponsors should be aware of potential challenges with respect to the LDI strategy and be prepared to make adjustments to the strategy where necessary.

Background – DB lump sum options

For certain types of DB plans – such as mature plans where the majority of participants currently receive annuities – the reliability and consistency of expected cash flows is high.[1] However, this can change when a plan offers lump sums; cash flow projections certainty diminishes. See Figure 1 below, which shows the benefit payment pattern for two plans, where one pays only annuities and where in the other, nearly all participants elect to take a lump sum distribution.

Figure 1: Comparison of the actual cash flow pattern of annuity vs. lump sum–paying plan



Source: Form 5500 filings, Department of Labor, as of July 2014. Available at: www.dol.gov

Lump sum options that are not part of a temporary window are protected plan features and usually cannot be eliminated.

Notice how the annuity-paying plan's cash flow pattern varies in a smooth, fairly predictable manner, whereas the lump sum–paying plan's cash flow pattern is volatile and harder to forecast. The annuity pattern is typical, because annuities are paid over a long period, with changes (retirements, deaths) only slightly affecting the overall pattern. In contrast, lump sum payouts vary significantly, as each is a one-time event per participant, and as timing and amounts can vary greatly between participants. This makes the payouts more sporadic.

Lump sum options that are not part of a temporary window[2] are protected plan features and usually cannot be eliminated. There are generally two main types of lump sum options for DB plans – those paid from traditionally designed DB plans, and those paid from hybrid plans (cash balance, pension equity, etc.). In a traditional DB plan (about a quarter of which offer lump sum options[3]), the benefit is defined and communicated as an annuity, then converted to a lump sum, using interest rate and mortality assumptions. In a hybrid plan, the benefit is defined and communicated as a lump sum; therefore, no conversion is necessary. The way lump sums affect LDI strategy is quite different for each plan type.

Cash flow duration and its importance to LDI

DB liabilities usually increase as interest rates fall, and DB sponsors generally lose funded status when rates fall, as has occurred repeatedly in recent history. In contrast, fixed income investors generally gain when rates fall.[4] DB plan sponsors can take advantage of these offsetting effects through LDI. The sponsor can help offset the interest rate risk of a DB plan's liability by investing in bonds with interest rate sensitivity similar to that of their liabilities. To know the interest rate risk, an LDI manager will often calculate liability duration and key rate durations (not covered in detail here), using the plan's expected cash flows provided by the actuary. We call this "cash flow duration."

An LDI manager will often calculate liability duration using the plan's expected cash flows provided by the actuary.

Once cash flow duration is known, the LDI manager can determine the appropriate bond mix to meet the sponsor's hedging goals. Unfortunately, when a DB plan offers lump sums, the duration calculated by use of expected cash flows is not necessarily a close estimate of the actual liability duration. Unlike plans paying only annuities, each projected cash flow may change when interest rates change.

Just as interest rates can affect lump sum cash flows, other actuarial methods and assumptions the actuary uses to produce the cash flows play important roles.

Actuarial equivalence assumptions

One key assumption that carries significant weight for the cash flows is the actuarial equivalence assumption – the basis for converting an annuity benefit into a lump sum. The lump sum benefit from a traditional DB plan is the present value of the annuity benefit, calculated using the actuarial equivalence assumption. The basis for the conversion has two components – the interest rate (used to discount payments) and the mortality table (used to estimate how many annuity payments will be made). Pension law requires that lump sum options be at least as large as calculated by use of the interest rate and mortality assumptions defined in IRC 417(e)(3).[5] An example of converting an annuity to a lump sum benefit is shown in Figure 2, below.

Figure 2: Example of IRC 417(e)(3) lump sum calculation age at 65

Assumes 2015 unisex IRS combined mortality and May 2015 interest rates; assumes beginning of year benefit payments

AGE	A ANNUITY BENEFIT	B PROBABILITY OF SURVIVAL	C: (A*B) EXPECTED BFT PMTS (CASH FLOWS)	D INTEREST RATE	E: $(1+D)^{-N}$ DISCOUNT FACTOR	F: (C*E) ANNUITY BENEFIT DISCOUNTED TO AGE 65
65	100	100%	100	1.38%	100%	100
66	100	99%	99	1.38%	96%	98
67	100	98%	98	1.38%	92%	95
68	100	97%	97	1.38%	89%	93
69	100	96%	96	1.38%	85%	91
70	100	94%	94	3.88%	82%	78
71	100	93%	93	3.88%	79%	74
72	100	91%	91	3.88%	76%	70
73	100	90%	90	3.88%	73%	66
74	100	88%	88	3.88%	70%	62
75	100	86%	86	3.88%	68%	59
76	100	84%	84	3.88%	65%	55
77	100	81%	81	3.88%	62%	51
78	100	79%	79	3.88%	60%	48
79	100	76%	76	3.88%	58%	45
80	100	73%	73	3.88%	56%	41
81	100	69%	69	3.88%	53%	38
82	100	66%	66	3.88%	51%	35
83	100	62%	62	3.88%	49%	31
84	100	58%	58	3.88%	47%	28
85+	100	…	…	4.98%	46%	119
			Present Value, Lump Sum, Sum of Column F			**1,377**

In this example, the age 65 annuity benefit of $100/year has a present value (lump sum value) of $1,377. The lump sum changes when either interest rate or mortality assumptions change. When using IRC 417(e)(3), which is set by the IRS, interest rates usually change every year.

Challenges in duration calculations and potential solutions

Consider a simple illustrative example. A DB plan has one plan participant, age 60 with a lump sum benefit due at age 65. We are trying to determine the liability duration by discounting cash flows.[6] Assume that both the liability discount rate and lump sum conversion rate are tied to a corporate bond yield curve and both are currently 4%. We show three scenarios for calculating liability and duration:

1. Lump sum paid at age 65 – lump sum conversion rate remains constant (static cash flows)
2. Lump sum paid at age 65 – lump sum conversion rate changes with the discount rate
3. Annuity paid at age 65 – prior to conversion to a lump sum

Liabilities are then calculated at 4% and 5%, and using both, we determine the cash flow duration (roughly the percentage change due to the interest rate change).

Figure 3: Cash flow example

Assumes 2015 IRS unisex combined mortality for liabilities and lump sum conversion.[7]

AGE	1) LUMP SUM CASH FLOW (CONVERTED ASSUMING 4% INTEREST)	2) LUMP SUM CASH FLOW (CONVERTED USING SAME RATE AS DISCOUNT RATE)	3) ANNUITY SUBSTITUTION
60	0	0	0
61	0	0	0
62	0	0	0
63	0	0	0
64	0	0	0
65	1,374	1,374/1,261[8]	100
66	0	0	99
67	0	0	98
68	0	0	97
69	0	0	96
70+	…	…	…
Liability (@ i=4%)	$1,129	$1,129	$1,129
Liability (@ i=5%)	$1,077	$988	$988
Cash Flow Duration	**5 years**	**14 years**	**14 years**

Scenario 1 reflects the actuary's best estimate for future benefit payments, but its cash flow duration (5 years) is inconsistent with actual liability duration, since the $1,374 lump sum will change as rates do (this scenario assumes conversion rates stay constant). Scenario 2 reflects the correct duration but does not result in a static set of cash flows, making it less useful for LDI purposes (the actuary would have to provide multiple sets of cash flows, and this would decrease the flexibility afforded to the LDI manager). Scenario 3 shows the correct duration as well, and has the added benefit of being static cash flows. The cash flow durations for Scenarios 2 and 3 are the same, indicating that annuity cash flows may be an acceptable method for determining liability duration. In contrast, using the lump sum cash flows (Scenario 1) could lead to under-hedging interest rate risk, as the lump sum cash flows, masking their actual sensitivity to interest rates, do not tell the complete story on liability duration.

An effective way to solve for issues related to lump sums could be to use the underlying annuity cash flows.

Under certain conditions, an effective way to solve for this issue is to use the underlying annuity cash flows in place of the lump sum cash flows. This means that the actuary codes all benefits as an annuity, even if the expectation is that most plan participants will take a lump sum. This is called annuity substitution and will result in cash flows as shown in Scenario 3. While this projection of cash flows may be a poor estimate of actual future benefit payments (as may be used to determine liquidity needs), it provides a more accurate estimate of the liability's interest rate sensitivity when duration and key rate duration are determined by discounting cash flows. Annuity substitution only works for this purpose when the liability

discount rate and lump sum actuarial equivalence basis are similar (e.g., both use corporate bond rates).

Annuity substitution does not apply when the plan's conversion rate is fixed. For example, if the conversion were based on a fixed 4%, then the lump sums themselves would not be sensitive to interest rate changes. Therefore, the lump sum–based cash flows (like Scenario 1) would be the best source for determining liability duration.

Another important aspect of the actuarial equivalence assumption to consider is whether the actuary uses a lump sum conversion rate assumption that is much different from the discount rate. As an example, assume the liability discount rate is 4%, but that the actuary assumes a lump sum conversion rate of 6%. Using the same parameters as above, the cash flows with lump sums could be dramatically lower than those assuming no lump sums. The liability calculated by use of those two sets of cash flows would differ significantly.

In DB plan design, many variations of lump sum actuarial equivalence exist.

In DB plan design, many variations of lump sum actuarial equivalence exist, such as using Treasury interest rates, the greater of two formulas, etc. but the IRC 417(e)(3) and fixed-rate assumptions are probably the most common. They are also the most easily understood and to factor into your LDI program. With less common actuarial equivalence provisions, cash flow duration uncertainty can increase, as other approaches to adjusting your LDI program become more complex.

In some cases, providing underlying annuities for LDI purposes will require extra work by the actuary, especially to produce these cash flows for the first time. Sponsors will therefore need to assess if the additional time/expense required is warranted to improve the effectiveness of the LDI strategy. If the cash flows including lump sums are sensitive to interest rates, an adjustment to the duration calculated by use of the projected cash flow must be made for purposes of LDI. If the sponsor is satisfied with a rough estimate, the duration of an average DB plan could be used.

Form of payment assumptions

Another major assumption that sets the future pattern of pension cash flows is the probability that a participant will elect a certain form of benefit payment (e.g., single life annuity, lump sum, etc.). For those plans that offer lump sums but where the take rate is lower, the effect on the LDI program will be less. On the other hand, if the take rate for a lump sum option is high, the factors mentioned above must be taken into account to maintain the effectiveness of the LDI strategy (the take rate for lump sums in Figure 1 was nearly 100%).

Closely tied to this assumption is the timing of benefits (i.e., when participants will retire and start receiving payments). The timing of payment assumption can be simple, such as all lump sums are paid at termination, or at age 65 (even though payments might be permitted anytime in between). While the actuary may believe these assumptions are adequate for liability purposes, they can significantly misrepresent the plan's liability duration, which over the long term reduces an LDI strategy's effectiveness. Even for more sophisticated assumptions, which provide a range of probabilities across ages based on historical experience and expectations for the future, the pattern will be volatile, and regular refinements may be necessary. The plan sponsor should work with the actuary to ensure that the assumption used is the best estimate, based on the plan's or a similar plan's experience.

While many corporate pension plans have now updated the mortality assumption for accounting liabilities, few have updated the mortality basis for lump sum conversions.

The mortality assumption

Another important assumption is mortality. While many corporate pension plans have now updated the mortality assumption for accounting liabilities,[9] few have updated the mortality basis for lump sum conversions.[10] A common valuation assumption is that lump sum mortality will remain as it is today (this is the default assumption). When a traditional plan that pays lump sums only updates liablity mortality (and not the conversion of the lump sum), the full effect of mortality is not realized in the liabilities (i.e., the liability increase is more mild), because expected lump sums are using "old" mortality. Therefore, the plan sponsor will have experienced a smaller increase in liabilities than otherwise comparable, annuity-only plans will have. Once the actuary updates lump sum mortality, sponsors can expect another liability increase related to mortality.[11]

If the mortality assumptions for liabilities and lump sum conversions are inconsistent with each other,[12] annuity substitution cash flows are likely to fully incorporate mortality, which means that both duration and liabilities will be higher than the cash flows that assume lump sums.

From one perspective, the sponsor may view using the annuity substitution cash flows, which fully reflecting the "new" mortality, as an advantage. They implicitly anticipate that lump sum mortality will change in the future. Thus, they estimate what the liability and duration will ultimately increase to, and they may be more comfortable using this basis for their LDI strategy. On the other hand, sponsors may wish to keep the present value of cash flows used in their LDI program and the valuation liabilities consistent. With some additional work, the plan's actuary can provide annuity substitution cash flows that convert benefits to lump sums using the current (old) mortality basis, then convert back to annuities using the updated (new) mortality basis (double conversion). This method would provide a consistent liability between the annuity substitution and lump sum cash flows.

Special considerations for cash balance plans

Almost all hybrid plans are lump sum–based. This is opposite to a traditional plan, where the benefit is annuity-based, but where the lump sum can be offered as a feature. Up to this point, our discussion has focused mostly on traditional plans that offer lump sums. Hybrid plans, such as cash balance plans, have different factors at play.

Cash balance accounts accrue a "pay credit" (percentage of pay) each year, and an "interest credit" (Treasury rate, fixed rate, or market return). If a plan freezes or the plan participant's employment terminates, the pay credits cease but interest credits continue.

When the actuary calculates the liabilities for a cash balance plan, they make an assumption for what the interest crediting rate will be in the future. If the rate is fixed (e.g., 4%), then this assumption is simple, and the cash flows are stable. However, if the interest crediting rate basis is floating (e.g., 30-year Treasury rate), then the interest crediting rate assumption will likely differ from the actual crediting rate, much as the future IRC 417(e)(3) interest rate will likely differ from the actuary's current assumption. When that assumption is revised as may be necessary for the valuation, the cash flows will change.

Annuity substitution cash flows should not be relied upon for all purposes.

In contrast to traditional plans that pay lump sums, there is no easy way to correct for this, but there are still ways to approach LDI, as liability duration still exists. The interest crediting rate assumption needs to be well understood, and it is likely that input from the actuary will be needed to correctly gauge the liability's duration.[13]

Other considerations

A common approach to addressing the issues raised with lump sums is the use of annuity substitution cash flows. In an LDI strategy, this helps to fine-tune duration calculations, but it should not be relied upon for all purposes. For example, expected cash flows are sometimes used to roll forward liabilities. It would not be appropriate to use annuity substitution cash flows in this case, since it would likely overstate the liabilities.[14]

Annuity substitution cash flows would also not be appropriate for determining liquidity needs – in other words, how much money you will need in the coming year in order to pay benefits. For this purpose, the plan should look to its own recent experience, a similar plan's experience and/or the actuary's best estimate of expected benefit payments (i.e., assuming lump sums are paid).

Conclusions and final thoughts

Sponsors of traditional defined benefit plans that pay lump sums and are pursuing LDI strategies ought to be aware of the potential issues they face. In order to determine the most accurate liability duration, they should understand the actuarial assumptions and methods under consideration. The assumptions most critical to understand are the actuarial equivalence, form of payment and mortality assumptions. It may be best for the LDI manager to request, from the actuary, the annuity substitution version of the cash flows to determine liability duration (and possibly key rate durations). Cash balance plans face another set of challenges that need to be understood and consciously addressed.

Potential issues are summarized in Figure 4.

Figure 4: Potential LDI issues for plans with lump sum benefit payment options

POTENTIAL ISSUE	EFFECT(S)	SOLUTION(S)
Interest rate sensitive lump sums	• Expected cash flows become interest rate sensitive • Cash flow duration is not equal to liability duration	• If liability and lump sum rates are on a similar basis, use annuity substitution cash flows
Overly simple form of payment assumption	• Unnecessarily high liability gains or losses • Inconsistent liability duration	• Discuss appropriateness of the assumptions with the actuary
Inconsistent liability and lump sum mortality assumptions	• Using annuity substitution cash flows leads to higher liabilities and duration than otherwise	• Accept the higher liabilities and duration as an early recognition of updated lump sum mortality assumption • Request that the actuary re-calculate annuity cash flows, using double conversion to be consistent with liability calculation
Variable cash balance interest crediting rate	• Expected cash flows become interest rate sensitive	• Evaluate the interest crediting rate assumption to determine what liability duration exists[15]

While offering lump sums adds an extra layer of complexity to an LDI strategy, this should not dissuade sponsors from pursuing LDI strategies for their plans. With a proper understanding and appropriate adjustments, LDI can reduce interest rate risk and help sponsors meet their objectives for their plans and the plan's participants.

[1] This is why, when we hear stories about annuity purchases, they typically just involve current retirees receiving only annuities. Insurance companies are more willing to take on retirees in payment, because there is much less risk than with participants who could elect a lump sum at some time in the future.

[2] For more information on temporary lump sum windows, see Owens, "Risk transfer options for defined benefit plan sponsors," Russell Investments Research, 2013.

[3] National Compensation Survey, 2010, Bureau of Labor Statistics – Table 33, "Defined benefit plans: Availability of selected benefit features, private industry workers." Also see Blostin, "Distribution of retirement income benefits," in Monthly Labor Review, April 2003.

[4] Other financial instruments, including derivatives like swaptions, can have similar characteristics, but for simplicity are ignored in this example.

[5] The interest rate basis in IRC 417(e)(3) uses current corporate discount rates, broken into three "segments," and for administrative convenience are often fixed for an entire year. Segment rates are roughly the average of rates from years 0 to 5, 5 to 20, and more than 20 years. Sponsors choose a "stability period," which is the length of time the assumption is fixed; and a "lookback period," which is how many months prior to the stability period they choose rates. Stability periods can be monthly, quarterly or annually. Lookback periods range from 0 to 5 months.

[6] Discount cash flows at two different rate and use the difference to calculate duration.

[7] Note that the annuity cash flow decreases after age 65 to account for the relative probability of death in any given year. We have assumed no pre-retirement mortality.

[8] 1,374 assumes a 4% lump sum conversion rate. 1,261 assumes a 5% lump sum conversion rate.

[9] See Owens, "How will the new RP-2014 mortality tables affect my DB plan strategy?" Russell Investments Research, 2014.

[10] Lump sums determined based on IRC 417(e)(3) currently use a similar basis as funding liabilities, which have not been updated to the new RP-2014 tables (in any variation) as of this writing.

[11] While it's likely that the mortality basis for lump sum conversions will be updated when funding liability mortality is updated, what is less certain is which mortality table will be used by the IRS.

[12] Note that technically, mortality assumptions for liability and lump sum purposes will always be inconsistent. This is because lump sums use a "unisex" table (mix of male and female rates), whereas for liabilities, actuaries use sex-distinct tables.

[13] For a more comprehensive treatise on LDI for cash balance plans, refer to Owens, Jaugietis & Sylvanus, "LDI for cash balance plans," Russell Investments Research, 2014.

[14] With a liability roll forward, benefit payments are removed. With annuity cash flows, benefit payments are spread over a longer period of time. Therefore, if annuity cash flows are used in the roll forward, not enough liability will be removed, overstating the final liability amount.

[15] For a more comprehensive treatise on LDI for cash balance plans, refer to Owens, Jaugietis & Sylvanus, "LDI for cash balance plans," Russell Investments Research, 2014.

Appendix

Summary of terms

TERM	DEFINITION (CORPORATE DB CONTEXT)
Annuity	A series of payments, typically payable until the annuitant's death
Lump sum	A one-time payment equal to the present value of an annuity benefit
Cash flows	Expected benefit payments for current participants – used to determine the discount rate and liability duration – the discounted cash flows are the plan's liability.
Liability duration	A measure for interest rate sensitivity – measures the percentage of change in liabilities for a 1% change in discount rate – best used for estimating the effect of small, parallel shifts in the yield curve
Key rate duration	Liability duration broken into maturity periods to measure interest rate sensitivity at various points in the yield curve in isolation – preferred to liability duration for measuring non-parallel shifts (twists, butterfly shifts) in the yield curve
Cash flow duration	Duration as calculated directly from the cash flows, rather than a actuary's valuation system
Mortality	Rate of death assumption – used in virtually all DB plans to determine expected number of annuity payments
Form of payment	The method of paying out promised DB benefits – includes single life annuities, joint & survivor, lump sum, etc.
Actuarial equivalence	A combination of interest and mortality rates used to convert annuities into other forms of payment, including lump sums
IRC 417(e)(3)	The code section that mandates a minimum level of lump sum benefits (and a few other less common forms of payment) by specifying the interest and mortality rates all converted lump sums must be compared with
Annuity substitution	Cash flows coded to generate annuities rather than lump sums, when lump sums would otherwise be assumed
Hybrid DB plan	A DB plan with DC plan features – benefit usually lump-sum-based – annuity must be offered – same funding/accounting requirements as traditional DB plans – includes cash balance and pension equity plans
Pay credit	The new accrual in a cash balance benefit – usually a percentage of pay
Interest credit	The "return" on a cash balance benefit – can be a fixed rate (e.g., 4%), a market-based rate (e.g., 30-year Treasury), a market-based asset return, or some combination of these

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