Embedded Options in Pension Plans

Catalogue of Embedded Options
Survey of Prevalence of Embedded Options

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SOA Pension Section

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Section I. Introduction

This research is the result of a request from the Society of Actuaries (SOA) to create reference material which will address and explore embedded options in defined benefit pension plans. We consider embedded options offered by a variety of different plan sponsors in both the private (primarily corporate defined benefit plans) and public sector (state and local defined benefit plans). This paper presents a catalogue of embedded options in pension plans, draws parallels between these contract features and those that exist in the life insurance industry and the financial markets, and provides the results of our survey on the prevalence of embedded options in defined benefit plans. This paper is Part I of a two part project. Part II of this research will be to provide a first step towards valuing these embedded option pension plan features. The intended audience of this paper is pension practitioners.

The term "embedded option" comes from the finance literature. The term refers to an option that is *part of and inseparable from*, a contract or financial instrument. The fact that the option is "embedded" in the instrument differentiates the option from a "stand-alone" option that can be purchased on an exchange or traded in the over the counter market. For example, many bond issues include a provision in the indenture that gives the issuer and/or the bondholder an option to take some action against the other party, such as the issuer having the option to call the bond at some point in the future and at some price[1].

It is useful to think of embedded options as belonging to the following two different categories:

- Category 1 - options driven primarily by employee behavior and/or by employee election (e.g. optional forms of payment).
- Category 2 - options *not* driven primarily by employee behavior and/or employee election. Rather, these options tend to be driven primarily from the behavior of underlying economic phenomena.

It is important to note that we should not get too distracted over these "categorizations" which are somewhat arbitrary. These categories are simply one way of cataloguing options that we found to be instructive. Based on discussions with the SOA POG, it became clear the effort is primarily concerned with the options we have bucketed into Category 2. A full description of each of the Category 2 options is included in Section III.

Category 1 options relate to options "granted" to plan participants under specific terms of the plan whose value is driven primarily by employee behavior. For example, provisions structured in the pension contract offering the participant the option to retire early or the option to elect a certain form of payment upon benefit commencement. While these options may be influenced by economic phenomena (the primary three phenomena considered in this paper being interest rates, equity market performance, and inflation rates), these factors can be viewed either as a) playing a secondary role to non-economic factors, or b) very difficult to isolate and quantify their contribution in driving participant behavior. For instance, the decision to retire early versus continuing to work, may indeed be impacted by the current economic climate. However, the economic environment tends to be thought of as influencing behavior more so as a *second* order effect as opposed to a *primary* order effect, i.e. there are other, non-economic factors that are really driving the participant decision (cultural norms, desire to spend time with family, health conditions, etc.). At a minimum, modeling the role the economic phenomena has played in driving participant behavior would be very difficult and outside the purview of this research.

[1] There are many texts that cover embedded option in financial instruments. For example, see Fabozzi *Fixed Income Analysis for Chartered Financial Analysts* for more details on embedded options in bonds.

Category 2 options, on the other hand, derive their value primarily from the behavior of the underlying economic variables. These options are either entire plan types (as in the case of a floor-offset plan) or distinct provisions of a plan that by analogy can be viewed as either being equivalent to, or very similar to, options or other derivatives on underlying economic and financial phenomenon that trade in the capital markets (hence the nomenclature for these type of plan features as embedded "options"). Essentially, the behavior of these plan provisions can be *replicated* by options and other financial instruments.

Category 2 embedded options, like the financial options they mirror, are characterized by the dynamic of "asymmetry". "Asymmetry" in the context of this paper means that the plan feature under consideration may be shown to have zero value if a single point estimate of the economic factor underpinning the plan feature is used. An example to illustrate will make the point clear. Consider a cash balance plan that credits interest using the return on the S&P500 index. The plan guarantees that the participant's account balance upon retirement could never be less than the sum of the pay credits earned under the terms of the plan. There is a value to the guarantee of the pay credits (this guarantee is commonly referred to in the pension world as "capital preservation"). However, if we value the plan assuming any positive rate of return on the S&P 500 index, the value of the guarantee will not be captured.

Another way to think about embedded options is as follows: if we have two identical cash balance plans that are the same in every way except that one guarantees principal and the other does not, these plans should not have the same value, unless of course, one *assumes* the value of the guarantee is zero. Using valuation techniques it should be possible to isolate the guarantee provision and value this separately from the rest of the cash balance plan provisions. We would then add the value of the guarantee to the value of the rest of the plan.

Under current actuarial practice, many of the embedded options in pension plans are not taken into account as part of funding and accounting valuations (the authors are not aware of how insurance companies price embedded options when a plan sponsor is looking to purchase annuities upon plan termination). Embedded option contract terms are usually ignored because they are *assumed* to have zero, or very little value. This conclusion is usually arrived at by "judgment" that suggests the probability of these options being "exercised" is extremely remote.

Little previous literature exists on the topic of cataloguing and documenting the prevalence of embedded options in pension plans. Although covered in Part II of this research paper, it bears mentioning here that there is also a relative dearth of literature on valuing embedded options with regards to pension plans in particular. There is however voluminous amounts of literature with regard to option pricing and valuation methods for derivatives. Moreover, for some time now, our life insurance practitioners have been valuing similar embedded option contracts that are prevalent in life insurance products. We make use of these sources on Part II of this paper where the focus is more on valuing the embedded option contract terms.

To date, the pension actuarial profession has only briefly touched on embedded options in defined benefit retirement plans. For example, *A Public Policy Practice Note - Selecting and Documenting Other Pension Assumptions* published in October 2009 by the American Academy of Actuaries stated the following with regards to embedded options:

> **Setting Assumptions for Floors, Ceilings, and Other Asymmetric Plan Provisions**
>
> For many common plan provisions, additional analysis may be appropriate for selecting some assumptions for a valuation in which variance in the assumptions affects the plan benefits asymmetrically. Thus approaches other than the expected value might be considered if variance in one direction does not have approximately the same effect as the same variance in the other direction. In these cases, probability distributions, stochastic modeling, or option-pricing techniques may be appropriate, either to value the

benefits directly, or to develop an adjusted assumption that reflects the interaction of the asymmetric plan provision with the underlying economic phenomenon.

Actuarial Standard of Practice No. 4 - Measuring Plan Obligations and Determining Pension Plan Costs or Contributions, published in September 2007 states in Section 3.9:

> **Inter-relationship Among Procedures, Assumptions, and Plan Provisions** - some plan provisions may create pension obligations that are difficult to measure using deterministic procedures and assumptions selected in ASOP No. 27 and ASOP No. 35. In such circumstances, the actuary may consider alternative procedures, such as stochastic modeling or option pricing techniques, or alternative assumptions that include adjustments to reflect the plan provisions that were not explicitly valued.

Recent developments have increased the focus of pension actuaries on embedded options in defined benefit pension plans. Volatile capital markets have either increased the value of some of these embedded options, or at the very least, highlighted to actuaries and plan sponsors alike that these contract provisions cannot be ignored. Many pension actuaries also witnessed their fellow life insurance actuaries face crises in late 2008 and early 2009 as the equity markets plummeted and life insurance contracts with embedded options, such as the minimum return guarantees in variable annuity contracts, threatened the survival of the companies that underwrote these policies.

The economic landscape and regulatory environment are also forcing companies to better understand the risk profile of their pension plan. As a result, actuaries are increasingly being called upon to model adverse economic scenarios and low-probability events. Often times it is under these stressed conditions where the embedded options have the most value and in turn the most cost to a plan sponsor.

Moreover, pension actuaries have become more familiar with the concepts of financial economics and market-consistent valuations for pension plan liabilities. Recently enacted pension funding rules and developments in pension accounting have migrated towards applying these principles. The liability measures used for these purposes now require actuaries to treat the pension plan obligations as "bond-like" cash-flows and thus to value the obligations using a high-grade corporate bond yield curve. Recently released exposure draft ASOP 27 and discussion draft ASOP 4, also emphasize fair value treatment of pension plan liabilities[2]. It follows by extension that a market-based approach to valuing a plan's obligations necessitates embedded options be valued by reference to similar contracts that trade in the capital markets or by using option pricing techniques with market derived inputs.

The current regulatory environment for cash balance plans in particular has also granted participants with certain embedded options. In October 2010, the IRS released final and proposed regulations related to cash balance plans that state that an interest credit cannot result in a participant's account balance at the time of payout being less than the aggregate amount of contributions credited to the account. The new regulations also allow plan sponsors to offer an annual floor on the interest crediting rate if the rate is tied to fixed income rates of return, and a cumulative floor on the interest crediting rate if the rate is tied to a diversified portfolio of assets.

In Section III, a number of common pension plan features that can be viewed as embedded options are catalogued. We describe the components and features of each embedded option

[2] ASOP 4 and ASOP 27 relate to all defined benefit plans. However, to the extent guidance in the ASOPs conflicts with applicable laws or regulations, the actuary is obligated to comply with the laws and regulations. Regulations for private sector plans have, in the past decade, generally moved to a more “fair value” paradigm when compared to regulations for public sector plans. That said, the point here is that in both sectors there has been a paradigm shift to more of “fair value” framework to value pension liabilities, although the pendulum has moved more in the private sector arena.

and describe the underlying economic processes driving value. We also draw similarities of these features to contracts that exist in the financial markets and the life insurance realm.

In Section IV we share the results of a survey on the prevalence of embedded options in pension plans in the United States and Canada. The results of the survey were meant to shed light on just how many of these options really are written into pension plans. Furthermore, the results of the survey would help determine which options warranted further study in Phase II of this research paper.

In short, the idea of embedded options in pension plans has not yet been fully explored. The contribution of this paper then is to further the study of these contract features that exist in pension plans.

Section II. Executive Summary

This paper catalogues the following Category 2 options:

- "Greater of" benefits - valuing a lump sum based on the greater result of using a variable interest rate and a fixed interest rate
- Floor-Offset plan
- Cost of Living Adjustments ("COLAs") with caps and floors or with a relationship that is not linear to the change in the applicable index
- COLAs that provide cost of living increases if market returns exceed a specified "hurdle rate"
- Cash Balance plans with caps and/or floors on the interest crediting rate
- Flat dollar minimum benefits and flat dollar maximum (cap/ceiling) benefits

Our survey produces the following key findings:

- Of the 134 private sector plans reported, 75 (56%) of them had at least one Category 2 embedded option written into the terms of the pension plan contract.
- The most prevalent Category 2 options (in terms of number of times it appeared as an option) in private sector plans are[3]:
    - Greater of benefits (27 times this option appeared as a feature of the pension plan)
    - Caps/ceilings (24 appearances)
    - Minimum benefits (19 appearances, respectively).
- Respondents overwhelmingly value the embedded options in their pension plans using best-estimate deterministic assumptions. Under this valuation technique, the risk and value of these contract provisions are likely not being taken fully into consideration.
- Actuaries for the most part have not changed their valuation techniques due to the recent economic climate. The objective of Part II of this research will be to provide practitioners with a roadmap for how to value embedded option plan features.
- Actuaries rarely draw distinctions between the valuation of embedded options for funding purposes versus accounting purposes. It is beyond the scope of this research to address whether the options should be valued differently for the two different purposes. However, it would seem, in keeping with the spirit and purpose of the standards, that for accounting purposes actuaries would want to take a fair value approach[4], whereas for funding, actuaries would want to evaluate the probability of the option being exercised, the exposure if it is exercised, and then determine how much funds they need to hold today in order to pay out the exercised option with a high level of probability. The amount of funds needed today would be the option value.
- Public sector plans contain embedded options primarily in the form of cost of living adjustments that commonly have floors and caps. Furthermore, public sector plans often grant cost of living adjustments that are conditioned on investment returns being greater than a certain hurdle rate. As discussed above, these plan features introduce optionality.

[3] Prevalence in terms of absolute number of times reported needs to be viewed in conjunction with the types and characteristics of the plans responding to the survey. While this caveat holds true for all the survey results (and survey results in general), it is especially true when evaluating prevalence. For example, had we received no cash balance plan responses, there would have been no minimum or maximum cash balance crediting rate options reported. This would not have meant that there were none of these options in existence and that they were not prevalent. We do provide figures and analysis in the "Survey Results" portion of this paper that breaks down Category 2 option types by a variety of different plan types and characteristics.

[4] See ASC 820 (formerly FAS 157 Fair Value Measurement) for more detail

Section III - Catalogue of Embedded Options

As referred to in the Introduction, this paper focuses on options whose value is tied to economic variables (Category 2 options). Options related to participant behavior (Category 1 options), while important in their own right, are not the topic of this paper. As such, they are not catalogued below. We do not claim that these are all the embedded options that exist in pension plans. Rather, based on discussions with the POG, we understand these are the main plan features desired to better assess their prevalence in today's pension plans.

This catalogue gives a generic description of the embedded plan options. The plan specific details of each option can differ from what is described below. Nevertheless, this catalogue will illuminate the major embedded option plan features.

We also briefly describe parallels of these options to other areas of financial services. The similarity of embedded options to other types of products and financial contracts will help in valuing these options.

The similarities drawn to other products are mainly to the life insurance industry. It is helpful to draw these parallels. First, pension practitioners may have some degree of familiarity with these products from their exam studies and experience dealing with life insurance actuaries. Second, the literature about how to value these features in a life insurance context can be adapted to the pension context. It is then a natural extension to view many of the pension plan embedded options as derivative-type contracts as this is commonly how they are viewed from a life insurance perspective.

A further exploration of the similarities amongst contracts and valuation techniques for embedded options in pension plans will be provided in Phase II of this research.

A. Greater of Benefits - valuing a lump sum (annuity) based on the greater result of using a variable interest rate and a fixed interest rate for conversions

Assume a plan participant may elect a lump sum at benefit commencement. The lump sum is determined by converting an annuity form of payment into the lump sum form of payment. To perform this conversion, a discount rate is needed to equate the two optional forms. The terms of the plan guarantee a fixed rate to perform this conversion that must produce a value for the lump sum at least as great as that derived from the prevailing market discount rate in effect at the time of benefit commencement (e.g. 30 year Treasury bond rate).

This type of plan provision feature can also work in reverse if the plan defines the normal form of benefit as a lump sum. In this case, the plan sponsor guarantees conversion to an annuity form of payment using a fixed rate of interest that must produce a value for the annuity at least as great as that derived from the prevailing discount rate in effect at the time of benefit commencement (e.g. 30 year Treasury bond rate).

In short, the plan sponsor has underwritten the risk that prevailing market interest rates will produce a higher lump sum benefit (or annuity) when compared to the fixed interest rate promised under terms of the plan. To the extent that the plan sponsor is obligated to pay out a higher benefit than the participant would receive if market rates were applied, the plan sponsor is effectively offering a “subsidy”, in the form of an embedded option, to the plan participant[5].

[5] While our focus in this paper is on the “greater of benefits” as we have described in this section, subsidies commonly show up in cash balance plan designs when a flat interest crediting rate is granted that is above market rates. Subsidies also appear in cash balance plans when a plan sponsor grants an interest crediting rate that cannot be hedged.

This type of plan contract is very similar to a Guaranteed Minimum Income Benefit (GMIB) issued by life insurance companies. A GMIB ensures the lump sum accumulated under a separate account contract may be converted to an annuity at a guaranteed rate[6].

The embedded option can also be viewed as a put option on the underlying interest rate used for the conversion held by the pensioner and underwritten by the plan sponsor.

"Greater of benefits" example:

Assume a defined benefit plan formula equal to 45% of the final three year average pay, and the final three year average pay is $58,000. Assume retirement happens at age 65. The monthly benefit from the defined benefit plan formula is:

[.45*$58,000]/12 = $2,175

Assume the plan states that conversion to a lump sum form of payment is the greater of the lump sum benefit produced using a fixed rate of interest of 6% or the lump sum interest rates prescribed under the Pension Protection Act of 2006 (PPA) in effect on the date of benefit commencement. Assume the PPA lump sum rates produce an effective rate of 6.5%[7] and the mortality table is the table prescribed under PPA for payment of lump sums.

Absent the fixed interest rate guarantee, the plan sponsor would owe the plan participant a benefit based on a lump sum factor using a 6.5% discount rate:

$2,175*10.66 = $23,186

With the fixed interest rate guarantee, however, the plan sponsor owes the plan participant a benefit based on a lump sum factor using the fixed rate of 6%. As shown below, this is because the value of the lump sum benefit is greater using the fixed rate of interest underwritten by the sponsor.

$2,175*11.09 = $24,121

In this case, the plan sponsor would be liable for an additional $935 ($24,121 - $23,186).

In generic terms, the payoff to the plan participant from the embedded option is:

Max (plan formula benefit with fixed interest rate guarantee - plan formula benefit without fixed interest rate guarantee, 0)

B. Floor-Offset Plans[8]

Floor-offset plans can be viewed as consisting of two separate plans. The first plan is a defined benefit plan which acts as a "floor" plan to the second plan. The second plan is a defined contribution plan which acts as a "base" plan. The defined benefit plan is established according to a standard formula, such as career average or final average pay. The defined contribution plan

[6] As GMIB is defined in Mary Hardy's *Investment Guarantees.*
[7] PPA lump sum rates are based on high-grade corporate bond yields and are divided into three segments based on duration of the benefit payments. For purposes of this section, the focus is on the guarantee the plan sponsor is providing not the intricacies of the lump sum rates under PPA.
[8] Portions of this section on Floor-Offset plans comes directly from *Pension Planning* Eighth Edition by Allen, Melone, Rosenbloom, and VanDerhei.

can be almost any common defined contribution structure, but typically a profit sharing plan is used.

If the defined contribution plan provides a benefit that equals or exceeds the minimum established by the defined benefit floor plan, then the participant receives the balance in the defined contribution account and no benefit is paid from the defined benefit plan. If the defined contribution plan provides less than the minimum benefit, then the floor plan makes up the difference between what the defined contribution plan is able to provide and the minimum benefit.

Frequently, these plans are designed to provide a defined benefit plan benefit that is expected to be small[9].

Floor-offset plan example

Assume the defined benefit plan formula is 45% of the final three year average pay, and the final three year average pay is $58,000. Assume retirement occurs at age 65. The monthly benefit from the defined benefit plan formula is:

[.45*$58,000]/12 = $2,175

Assume the defined contribution plan is a profit sharing plan with a retirement balance of $144,000 and that the factor to convert the profit sharing balance to a monthly annuity at age 65 is fixed at 120. The profit sharing balance, converted to a monthly annuity value, is:

$144,000/120 = $1,200

To calculate the benefit to be paid from the defined benefit floor plan subtract the monthly annuity payable from the defined contribution plan from the monthly annuity payable from the defined benefit plan:

$2,175 - $1,200 = $975

If the subtraction above yielded a negative dollar amount, then no benefit would be payable from the defined benefit plan. In our example, the benefit due to the participant from the defined benefit portion of the floor-offset plan is a monthly annuity of $975 payable at age 65.

We are interested in the floor-offset example because it contains an embedded option that is affected by an unpredictable economic variable. In this case, the investment return on the defined contribution plan is the primary underlying economic phenomenon we are concerned about. It is apparent that a defined contribution balance of $261,000 or higher ($261,000/120 = $2,175) would lead to $0 benefit in the defined benefit plan. However, a balance less than $261,000 would create liability in the defined benefit plan. This behavior clearly exhibits the dynamics of asymmetry described in the Introduction.

In generic terms, the payoff at retirement of the floor-offset plan is:

Max (defined benefit plan benefit at retirement - defined contribution plan benefit at retirement, 0)

[9] Technically, if a floor offset plan uses an ESOP as the DC plan which provides the offset, the offset is limited to 10%. This limit is imposed because if there were no limit and the company went into bankruptcy (ESOP offset = $0) the PBGC would be liable for the entire obligation.

In their paper, "The DB Underpin Hybrid Pension Plan: Fair Valuation and Funding"[10], Hardy and Chen apply a financial engineering approach to valuing the excess of the guaranteed defined benefit plan benefit over the defined contribution plan. Hardy relates the Floor-Offset plan design to an exchange option (also known as a Margrabe option). An exchange option offers the option to exchange the lower plan benefit for the higher plan benefit.

C. Cost of Living Adjustments (COLAs) with caps and floors or with a relationship that is not linear to the change in the applicable index (CPI)

Pension annuities are typically paid in one of two ways - either as a fixed amount or as an amount indexed to some market variable. A fixed amount means that once a pensioner has commenced his/her annuity, the benefit remains fixed over the payment period. If the benefit is indexed, the benefit will change depending on how the indexing is defined under the terms of the pension plan. For example, a plan may provide for increases in a pensioner's benefit equal to the change in the Consumer Price Index (CPI) over the year[11]. Some pension plans place a floor and/or a ceiling on the amount of increase to be credited each year. For instance, a pension plan may be written so that each pensioner's benefit is increased by the change in the CPI over the year but by no less than 3% and no greater than 5%. Most plans that index benefits provide a floor of 0% and some type of cap or ceiling. Over the years, pension plan sponsors have written a host of different types of indexing provisions. We discuss some of the more common features below.

Indexed benefit contract terms tend to be quite prevalent for government sector plans and less so for private sector plans. These features are also prevalent in Europe, especially the United Kingdom where legislation introduced different kinds of "cap and collar" benefit provisions which plan sponsors are obligated to provide retirees in certain circumstances.

<u>COLA with cap and floor *annual* adjustment example</u>

Assume a defined benefit plan formula equal to 45% of the final three year average pay, and the final three year average pay is $58,000. Assume retirement occurs at age 65. The monthly benefit from the defined benefit plan formula is:

[.45*$58,000]/12 = $2,175

Assume the pension plan is written such that retirees receive an annual cost of living adjustment beginning in January based on the change in CPI during the prior year. Assume the cost of living adjustment cannot be less than 1% (floor %) and cannot be greater than 4% (cap %).

Assume the participant begins his pension at age 65 on January 1. The participant is now age 66. The change in CPI over the prior year is 5%.

The pension benefit payable at age 66 on January 1 is equal to:

$2,175*(1+.04) = $2,262

Or in generic terms:

Pension Payment*[min(max[1+floor%, 1+change in CPI],1+cap%)]

[10] Mary R. Hardy and Kai Chen, The DB Underpin Hybrid Pension Plan: Fair Valuation and Funding, North American Actuarial Journal

[11] As the goal of a cost of living adjustment is to preserve a pensioner's spending power with respect to inflation, it is logical that the indexed pension annuity is tied to a cost of living index like the Consumer Price Index. For ease, we simply use the terminology "CPI" though we realize there are many CPI indices (e.g. CPI-U, CPI-W, etc.)

In this example, the cap on indexation is exercised by the plan sponsor as the change in CPI of 5% is greater than the ceiling of 4% that exists under the terms of the plan.

More complicated indexing of benefits may also exist. For example, in some cases the benefit is indexed by a certain percentage of the applicable index up to a certain amount and a different percentage of the index in excess of that certain amount.

There may also be situations where there is a cumulative or "catch-up" COLA or a maximum on the compound increase that can be earned. In this scenario, the benefit is indexed so that on a cumulative basis the increase is never less (or more) than a pre-determined percentage (for example, 3%) compounded since retirement.

The underlying economic variable in this case is the index used to apply the COLA. In our example, CPI is the random component. The unpredictable nature of CPI and similar indices is the reason we have included COLAs in our analysis.

The types of pension plan contract terms we have described above are similar to equity indexed annuities (EIA) commonly offered in the U.S. by life insurance companies. A typical EIA guarantees a minimum return (normally 3%) (on the portion initially invested). In addition to the minimum guarantee, the policyholder receives some participation of appreciation in a pre-determined stock index[12]. The key difference here is that the underlying economic phenomenon with which the annuity fluctuates is a measure of inflation as opposed to a measure of equity performance.

The embedded option with floor and cap can be viewed as a combination of both a put option on the underlying inflation rate used for granting pension increases held by the pensioner and underwritten by the plan sponsor and a call option on the underlying inflation rate held by the plan sponsor and "underwritten" by the plan participant.

D. Cost of Living Adjustments (COLAs) that provide cost of living increases if market returns exceed a "hurdle rate"

These option types are similar to the types discussed above except that indexation of plan benefits is contingent on the plan achieving a certain rate of return[13]. These types of provisions are sometimes referred to as "gain-sharing". A contract could be written to determine the cost of living adjustment by applying a formula to the amount of investment return above a pre-specified return, say 9%. Herein, we refer to the "pre-specified return" as the "hurdle rate".

We provide an example to demonstrate how, in general, these types of cost of living increases are structured. We start with the same benefit formula as we have been using throughout:

Assume a defined benefit plan formula equal to 45% of the final three year average pay, and the final three year average pay is $58,000. Assume retirement occurs at age 65. The monthly benefit from the defined benefit plan formula is:

$$[.45*\$58,000]/12 = \$2,175$$

[12] This description is from X. Sheldon Lin and Ken Seng Tan, "Valuation of Equity-Indexed Annuities under Stochastic Interest Rates"

[13] We are also aware of COLAs that are contingent on the funded status of the plan. These types of plan features were outside the scope of our effort.

Assume the plan grants cost of living increases equal to the excess investment return on the plan over 9%. If the plan earns less than 9% return, no cost of living adjustment is granted. Assume the plan earned a return of 12%. The cost of living adjustment would be computed as follows:

The pension benefit payable at age 66 on January 1 is equal to:

$$\$2,175*(1+.03) = \$2,240$$

Or in generic terms:

Pension Payment*[1+max(0,actual investment return minus hurdle rate)]

Similar to the COLA indexation discussed in Section D, “gain-sharing” provisions can be structured in many complex ways.

Contract provisions that index benefits to the equity markets and provide some sort of floor provision function much like equity indexed annuities (discussed above).

The type of embedded option discussed in this section can be viewed as a call option on the underlying investment return rate used for granting pension increases that is held by the pensioner and underwritten by the plan sponsor.

E. Cash Balance Plans with Caps and/or Floors on the Interest Crediting Rate

Cash balance plans express benefits in terms of lump sums of individual hypothetical accounts equal to annual pay credits accumulated with annual interest credits.

The plan provides to each eligible participant a pay credit each year. Pay credits receive a return that is called an "interest crediting rate". For example, if a participant earns $100,000 per year and the plan defines the pay credit as 5%, the plan will provide a pay credit to this participant of $5,000. For simplicity, assume the interest credit is granted at year end. If we assume an interest crediting rate of 5%, the participant’s balance at the end of the next year would equal $5,000 * (1.05) plus the current year's pay credit. The cash balance benefit formula is lump sum based whereby the accumulated benefit is expressed as the current balance of a hypothetical account. The participant (once he fully vests) can commence his benefit as a lump sum equal to the hypothetical account balance. Optional forms of benefit are also available and the plan can define those to be actuarially equivalent to the participant's account balance. Interest credits accrue in the plan until a participant commences his/her benefit. For example, if a participant terminates at age 40 but does not commence his/her benefit until age 65, interest credits will continue to accrue from age 40 to age 65 at whatever interest crediting rate is defined under the terms of the plan during the time the pay credits were earned.

The IRS specifies allowable interest crediting rates. IRS Notice 96-8 details safe harbor rates. Regulations passed in 2009 and 2010 expand the permissible interest crediting rates. Plan sponsors can now define the interest crediting rate by reference to the first, second, or third segment corporate bond yields specified by the United States Treasury Department for use under the Pension Protection Act of 2006 (the current set of U.S. pension funding rules). Moreover, the IRS now permits pension plan sponsors to credit a market rate of return to participant accounts if the return is based on a diversified asset portfolio. Lastly, the IRS allows plan sponsors to credit a fixed rate of return equal to 5%.

Relating to cash balance plans, there are three contract features that can be viewed as embedded options. All three are related to caps and/or floors on the interest crediting. The three contract features are as follows:

1) Capital preservation - a participant cannot receive a benefit less than the sum of his/her pay credits earned under the terms of the plan. The participant essentially owns a put option with an exercise price equal to the sum of the pay credits. Cash balance plan regulations issued in October 2010 by the Internal Revenue Service put into law that all cash balance plans are subject to the capital preservation guarantee.

2) Up to 3% cumulative interest credit guarantee - similar to capital preservation except instead of 0% cumulative interest guarantee, the plan sponsor, regardless of the interest crediting rate contracted under the terms of the plan, may guarantee up to 3% cumulative interest on each pay credit earned until annuity commencement. This embedded option can also be viewed as equivalent to a put option held by the plan participant.

3) Floor on annual interest credits - if the plan sponsor credits interest based on some underlying bond index, the sponsor may underwrite a guarantee that the interest credit granted each year is not less than some floor percent. This embedded option type can be viewed as equivalent to an interest rate put option owned by the plan participant.

Note, there are significant differences in these three options in the sense that the floor on *annual* credits applies to the entire cohort of participants *regardless* of past performance of the interest crediting rate. Meanwhile, the first two options really depend on participant specific factors (for example, when the participant entered the plan and how the interest credits have evolved over time along with the size of the pay credits earned by the participant, etc.). As a result of this dynamic, the first option exhibits a much different risk profile to the plan sponsor because it possesses this "all or nothing" behavior. The latter two options will exhibit some amount of "diversification" because some plan participants may have an "in-the-money" guarantee at the same time other participants' guarantees are "out-of-the-money"[14].

The following describes in more detail each of these embedded options:

E1) Capital Preservation Guarantee

The new IRS regulations mandate a cumulative floor interest crediting rate of 0%. This practically applies to a case where the cumulative interest crediting rate could be negative. Therefore, at a minimum, when a participant retires and commences his/her pension benefit, the benefit cannot be less than the sum of the pay credits granted to the participant under the terms of the plan. Herein, this guarantee is referred to as "capital preservation". These types of provisions exhibit the asymmetric features discussed in earlier sections. The guarantees provided by the plan sponsor are not "free".

Two plans with identical contract provisions in every way except for the fact that one plan offers capital preservation and one does not, should *not* have the same value (unless it is concluded the option value is zero). The plan sponsor has underwritten the risk that the cash balance plan account balance cannot be less than the sum of the pay credits. This guarantee can be viewed as a cost to the plan sponsor and a benefit to the plan participant.

E2) Cash Balance Plan with 3% cumulative interest credit guarantee

[14] This same principle applies with respect to the cost of living adjustments described in the previous section. Cost of living adjustments applied annually will affect an entire cohort of participants, whereas cost of living adjustments applied on a cumulative basis depends on a host of other factors.

The new hybrid plan regulations allow for up to a 3% floor to be applied to all pay credits earned. This cumulative floor can be combined with any IRS permissible interest crediting rate. Therefore, at the participant's annuity starting date, the benefit is equal to the greater of the benefit determined using the interest crediting rate and that determined as if the plan had used a fixed rate of interest crediting rate equal to 3% in all years. This guarantee is essentially the same as the capital preservation guarantee except rather than guarantee 0% cumulative return, this provision allows for up to a 3% cumulative guarantee.

E3) Cash Balance Plan with Annual Interest Crediting Rate Guarantee

Another type of embedded option that may be prevalent in cash balance plans is an annual interest crediting rate floor. Under recently released hybrid plan regulations, a plan that credits interest in accordance with a permissible bond rate can provide an annual floor on the interest credit earned of up to 4%. Our survey results show that even prior to the new regulations some cash balance plans were providing a floor interest crediting rate to plan participants. It is likely these floor provisions were put in place either to comply with IRS back-loading rules or to ensure participants were accruing a certain level of interest per annum.

Regardless of the reason for including such provisions, any cash balance plan feature that credits interest each year equal to the max (floor rate, bond rate) can be viewed as equivalent to a series of annual interest rate puts. The participant is essentially long a series of these puts and the plan sponsor is essentially short these options having underwritten the risk to provide this floor benefit to the participant.

F. Flat dollar minimum benefits and flat dollar maximum (cap/ceiling) benefits

A flat dollar minimum benefit puts a floor on the benefit a participant can earn under the terms of the pension plan contract. On the other hand, a flat dollar maximum benefit places a cap on the benefit a participant can earn under the pension plan. In this section, we assume the minimum benefit and the maximum benefit are a fixed dollar amount.

We can use our example from earlier to first illustrate the application of a minimum benefit. We will then use the example to illustrate the application of a maximum benefit.

Assume a defined benefit plan formula equal to 45% of the final three year average pay, and the final three year average pay is $58,000. Assume retirement occurs at age 65. The monthly benefit from the defined benefit plan formula is:

$$[.45*\$58,000]/12 = \$2,175$$

Assume a minimum monthly benefit at retirement equal to $2,500. Therefore, the monthly benefit actually payable to this plan participant at 65 is $2,500 and not $2,175. The plan sponsor in this situation would be responsible for an extra $325 per month ($2,500 less $2,175) being paid to the plan participant.

In generic terms:

Pension benefit = max (pension formula, minimum benefit).

The plan sponsor’s additional liability for the minimum benefit at commencement would equal:

Max (0, minimum benefit - pension formula).

A minimum benefit provision can be viewed as being very similar to a Guaranteed Minimum Maturity Benefit (GMMB) offered by many life insurers. A GMMB guarantees a life insurance policyholder a specific monetary amount at maturity of the contract. These types of provisions are commonly written into equity-linked contracts that offer the policyholder participation in the performance of an underlying equity index (or indices) with a guarantee being provided by way of the GMMB clause in the contract[15]. We can view the flat dollar minimum benefit written into the terms of the pension plan to function in much the same way as the GMMB feature. In this context, the minimum benefit can also be thought of as a put option with an exercise price equal to the minimum benefit amount "owned" by the plan participant. The payoff to the plan participant would be the pension benefit computed under the standard formula described in the plan plus any residual piece owing to the difference in the minimum benefit and the pension formula benefit, if applicable.

A maximum benefit provision operates in much the same manner as the minimum benefit provision. The difference here is that now the plan sponsor holds a call option on the value of the pension formula that can be exercised against the annuitant.

[15] This is how GMMB is defined in Mary Hardy's *Investment Guarantees.*

Section IV - Survey of Embedded Options in Pension Plans

A. Objectives

We conducted a survey to evaluate the prevalence of embedded options in pension plans. Moreover, we were interested in how pension actuaries were currently valuing these types of plan provisions. Given that Category 2 options are tied to economic variables, we also wanted to understand if there had been any change in valuation methodology given the recent turbulence in the markets and world economy.

The prevalence, or lack thereof, of each plan feature was to be used as a determining factor in deciding which options warranted further study regarding valuation techniques.

Our findings are based on the survey results as reported by respondents. Because a portion of the survey results was provided anonymously by non-PwC practitioners, we were unable to follow-up on any oddities[16] that emerged when reviewing survey replies. Notwithstanding this fact, we believe the main findings from the survey are sound.

B. Key Findings

- Of the 134 private sector plans reported, 75 (56%) of them had at least one Category 2 embedded option written into the terms of the pension plan contract.

- The most prevalent Category 2 option (in terms of number of times it appeared as an option) in private sector plans is: greater of benefits (27 times this option appeared as a feature of the pension plan). Caps/ceilings and minimum benefits were a close second (24 and 19 appearances, respectively)[17].

- Respondents overwhelmingly value the embedded options in their pension plans using best-estimate deterministic assumptions. Under this valuation technique, the risk and value of these contract provisions are likely not being taken fully into consideration.

- Actuaries for the most part have not changed their valuation techniques due to the recent economic climate. The objective of Part II of this research will be to provide practitioners with a roadmap for how to value embedded option plan features.

- Actuaries rarely draw distinctions between the valuation of embedded options for funding purposes versus accounting purposes. It is beyond the scope of this research to address whether the options *should* be valued differently for the two different purposes. However, it would seem, in keeping with the spirit and purpose of the standards, that for accounting purposes actuaries would want to take a fair value approach[18], whereas for funding, actuaries would want to evaluate the probability of the option being exercised, the exposure if it is exercised, and then determine the amount of funds they need to hold today in order to pay out the exercised option with a high level of probability. The amount of funds needed today would be the option value.

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[16] We note limitations of the survey in Section F of this section

[17] Prevalence in terms of absolute number of times reported needs to be viewed in conjunction with the types and characteristics of the plans responding to the survey. While this caveat holds true for all the survey results (and survey results in general), it is especially true when evaluating prevalence. For example, had we received no cash balance plan responses, there would have been no minimum or maximum cash balance crediting rate options reported. This would not have meant that there were none of these options in existence and that they were not prevalent. We do provide figures and analysis in the "Survey Results" portion of this paper that breaks down Category 2 option types by a variety of different plan types and characteristics.

[18] See ASC 820 (formerly FAS 157 Fair Value Measurement) for more detail

- Public sector plans contain embedded options primarily in the form of cost of living adjustments that commonly have floors and caps. Furthermore, public sector plans often grant cost of living adjustments that are conditioned on investment returns being greater than a certain hurdle rate. As discussed above, these plan features introduce optionality.

C. Survey participants

The survey was distributed to approximately 80 pension practitioners employed by PwC. The survey was also disseminated by the SOA through email to all members of the Pension Section in both the United States and Canada.

From publicly available information (generally through each municipality's website, 50 plans offered by cities and 76 plans offered by states), we obtained information on embedded options offered in public sector pension plans. Where plan provisions differed depending on when an employee was hired or based on some other characteristic, we summarized the provision applicable to the largest number of participants and to newly hired participants. As the intent of the survey was not to focus solely and primarily on public sector pension plans, we have consolidated all retirement system plans, whether state, local, teacher, fire, etc.., as one group labeled in the graphs below as "Public Sector Systems". Moreover, we have no reason to believe the combining of these plans into one broad category should detract from the findings of the survey.

Survey information was collected from March 1, 2010 through May 31, 2010.

D. What the survey asked for

1. General information about both the plan sponsor and the plan:

    - Industry of the sponsor offering the pension plan (automotive, technology, etc.)
    - Canadian pension plan or U.S. pension plan
    - Number of plan participants
    - Market value of assets
    - Plan design (career average, cash balance, final average, flat dollar, etc.)
    - Qualified or non-qualified pension plan
    - Union or non-union employees covered by the plan
    - New accruals in the plan or frozen plan
    - Plan closed to new entrants
    - Public company or private company sponsoring the plan
    - Employee contributions in the plan
    - Multi-employer plan
    - Multiple employer plan

By gathering both plan sponsor specific and plan specific information, we could assess if there were trends or patterns in the plan features offered. For example, it became clear that many public sector plans offered cost of living adjustments that either had caps and/or floors on the amount of increase that could be granted in any one year.

To be complete, we included some Category 1 options, although as stated previously, the POG was more interested in Category 2 plan features. The survey was constructed broadly along the lines of Category 1 and Category 2 options discussed in the Introduction with options being separated into two buckets: company/employee behavioral options and financial/investment embedded options. These two buckets correspond with Category 1 and Category 2 descriptions

we have noted. The embedded options contained in the survey are listed below, separated by our two categories.

2. Selection of which options exist in the pension plan

- Category 1 Options

  - Deferred retirement beyond normal retirement date
  - Commence disability benefits
  - Commence early retirement benefits
  - Optional forms of payment

- Category 2 Options

  - "Greater of" benefits - valuing a lump sum based on the greater result of using a variable interest rate and a fixed interest rate
  - Floor-Offset plan types
  - Cost of living adjustments (COLAs) tied to inflation with caps and floors on the amount of adjustment that can be applied
  - COLAs tied to market performance where the COLA is granted if market return exceeds a pre-specified hurdle rate
  - Minimum or maximum cash balance interest crediting rates
  - Minimum benefits
  - Maximum benefits

3. Selection of techniques used to value embedded option

- Valuation Technique

  For each of the embedded options noted above, we requested the respondent indicate how the provision was being valued. A number of different valuation methods were listed as follows:

  a. Deterministic approaches/actuarial assumptions of incidence
  b. Simulation and scenario testing
  c. "Option-Valuation" techniques (Black-Scholes)
  d. Approximation/Load/Rule of thumb (based on experience)
  e. Not valued/non-material liability
  f. Other (provided by survey respondent)

<u>Overview of valuation techniques for survey purposes</u>

A more detailed description of the techniques to value embedded options will be discussed in Part II of this paper. Here we provide a brief and general description of the methods that were used as guidelines for practitioners to respond appropriately to the survey.

a. Deterministic approaches/actuarial assumptions of incidence (multiple ages/(single age))

   Under current actuarial guidelines, most pension plan provisions are valued using deterministic assumptions. This means that the actuary makes a "best guess" regarding assumptions to value the plan provisions under consideration (the use of select assumptions for a certain time period and ultimate assumptions for a certain time period can be used to address divergent views about short term and long term assumption

behavior). If the option is valued assuming a single point assumption for the underlying phenomena driving the options value, then the actuary should select this valuation technique.

A distinction was made in the survey between deterministic approaches at "multiple ages" and at "single ages". The difference in these two approaches simply relates to whether the actuary's deterministic assumptions apply at more than one participant age. For example, if the actuary is using deterministic assumptions to value early retirement benefits and is assuming the participant can retire at multiple ages, then the actuary should select "deterministic - multiple ages" as his choice for valuation technique.

The choice of "single age" or "multiple age" should not cloud the bigger picture objective here which is to learn what valuation technique the actuary is using to value the embedded option(s) in the plan.

b. Simulation and scenario testing

Simulation refers to using stochastic simulations to project values for the underlying variables that influence the value of the embedded option. For example, if you consider a stock option, a stochastic simulation would look to generate outcomes for the path of the stock over the term of the option contract. This approach uses a process to randomly determine a sequence of observations for each variable in question. In effect, we are deriving the approximate distribution for the guarantee liabilities and then discounting these liabilities at the assumed rate of return the assets are invested in or via a discount rate required by a regulator (for example, the IRS or FASB).

In general, there are several stages or prerequisites to performing a stochastic valuation as follows:

1. Identify the underlying economic variables driving option value
2. Select a suitable model for simulating these underlying economic variables
3. Select model parameters
4. Simulate and obtain economic variable scenarios
5. Select actuarial assumptions for stochastic option valuation engine
6. Input economic variable scenarios into stochastic simulation engine and calculate values for each scenario
7. Calculate expected value of option scenarios

Scenario testing refers to performing "shocks" to the "best-estimate" deterministic assumptions typically used to perform actuarial valuations. Scenario testing would illustrate the value of the plan embedded option in the event that experience turns out different from the best-estimate forecasts.

If a survey respondent uses either of the above approaches, he/she should have indicated this valuation technique when completing the survey.

Also, if a respondent used stochastic simulation to augment the assumption used to value the pension obligation, this approach would have been selected. For example, say the plan credits a COLA tied to inflation, with a cap of 3%. The inflation process could be stochastically modelled with a resulting distribution being constructed. This distribution would then be augmented for the fact that inflation is capped at 3%. A new resulting distribution is thus established. The plan actuary could then use the mean or median result of the new distribution function as the inflation assumed used to value the indexed annuity.

c. Option valuation techniques

As we have discussed above, certain plan features can be viewed as being equivalent (or quasi-equivalent) to option contracts traded in the capital markets. If an actuary was valuing these plan features (embedded options) by reference to market prices for these similar contracts he/she should have elected this valuation technique. Moreover, if an actuary was using methods commonly used to price options via closed-form solutions (for example, Black-Scholes formula or the Black Formula) or by numerical methods (such as risk-neutral Monte Carlo simulation or trees (binomial/trinomial, etc..) he/she should have elected this valuation technique. If an actuary discounts cash flows using market-consistent assumptions he/she should have also selected this technique.

The options valuation technique would provide a value that would approximate what the pension plan feature would be priced at if it were a tradable instrument in the market. Another way to think about this valuation technique is that using this approach would value the option as the cost to the plan sponsor to go out into the capital markets and buy instruments to hedge the risk of the plan feature.

This approach could also be called a “replicating portfolio approach” as the objective is to *replicate* the behavior of the plan feature by identifying capital market instruments that behave the same way.

d. Approximation/load/rule of thumb

Actuaries may apply a "rule of thumb" estimate to the value of the embedded option under consideration. A "rule of thumb" approach would be used in lieu of the more robust mathematical calculations that are needed under the options pricing and simulation valuation methods. For practical reasons, for example, consideration of the trade-off between the level of precision in value and the time spent implementing more robust procedures, using a rule of thumb approach may be appropriate. If an actuary applied some estimate or approximation to account for the value of the embedded option, he/she would elect this valuation technique.

e. Not valued/immaterial

If a survey respondent deemed the value of the embedded option to be immaterial, he/she should have selected this option. Moreover, if a practitioner has not valued the option this valuation technique should have been chosen. We did not inquire about the reasons why an actuary would disregard a valuation.

f. Other

If a survey respondent used another technique other than the ones we have described herein, we asked him/her to select this option and indicate as such.

4. Additional Questions

We asked two additional questions to round out the survey:

- Is the option valued the same for accounting and funding?
- Has the methodology for valuing the option changed due to the current market climate?

We were curious if respondents were taking different approaches under accounting and funding regimes to value the embedded options in their pension plans. For different purposes, the value of the obligation may be different. For example, a termination liability is different than an accounting liability due to the different purposes and requirements of each valuation. We wondered if the embedded option itself would be treated differently for the two purposes.

We also were interested in whether any respondent had changed his methodology for valuing embedded options due to the current market climate. As discussed in the Introduction, one of the reasons this study was initiated was because the market collapses in 2000-2002 and 2008-2009 highlighted the risk that many of these contract features posed to plan sponsors. This occurrence, coupled with the migration of accounting and funding rules to a more mark-to-market paradigm, made us curious as to how valuation techniques for embedded options in pension plans may be evolving.

E. Survey Results

The survey results focus primarily on the Category 2 embedded options, as this is the main focus of this paper. We found that Category 1 options are prevalent in the majority of pension plans and are valued deterministically. Coupled with the fact that the results are fairly uniform for these option types, we did not separately graph their results.

a) Summary Plan Information - Figures 1-5

The following three figures display summary information for the plans surveyed in both the private and public sectors.

Figure 1 - Summary Plan Information for the Non-Public Sector Plans Surveyed (134)

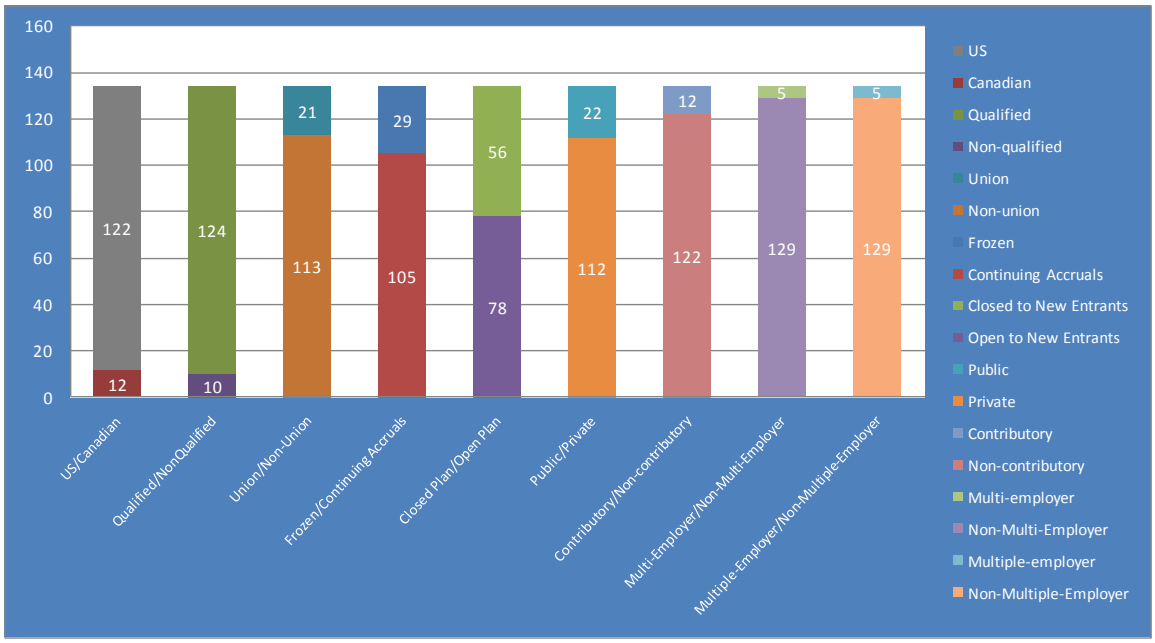
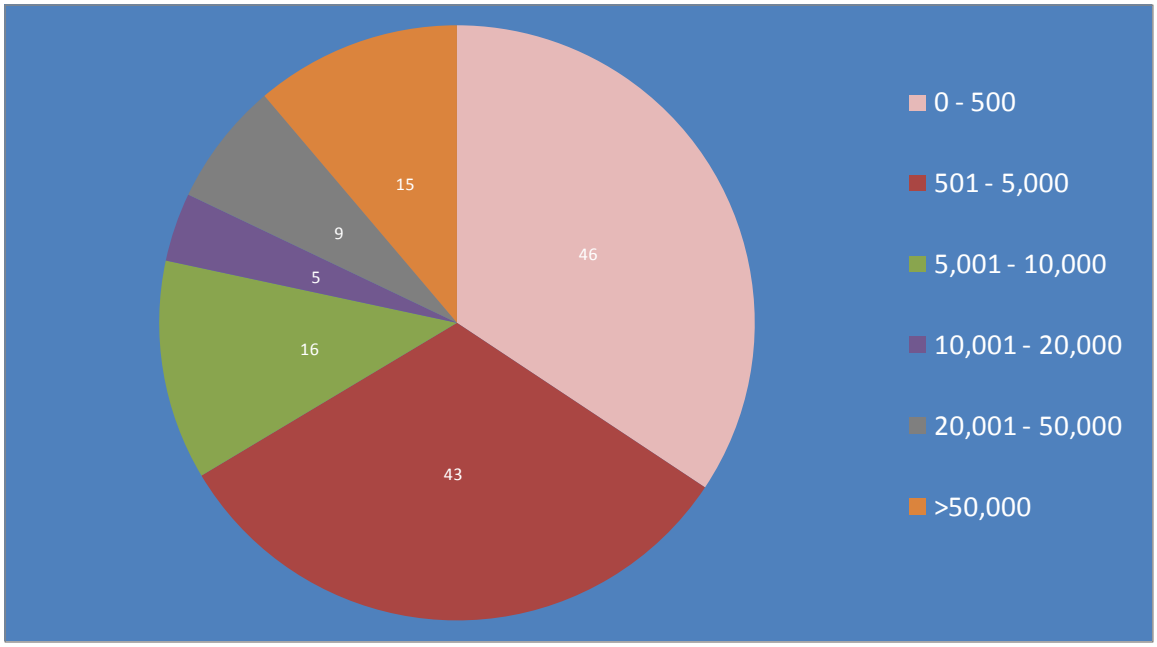


Figure 1 shows summary information for the non-public sector plans reported. This figure is meant to give a broad illustration of the types of plans that responded to the survey. Key observations of the plans surveyed are:

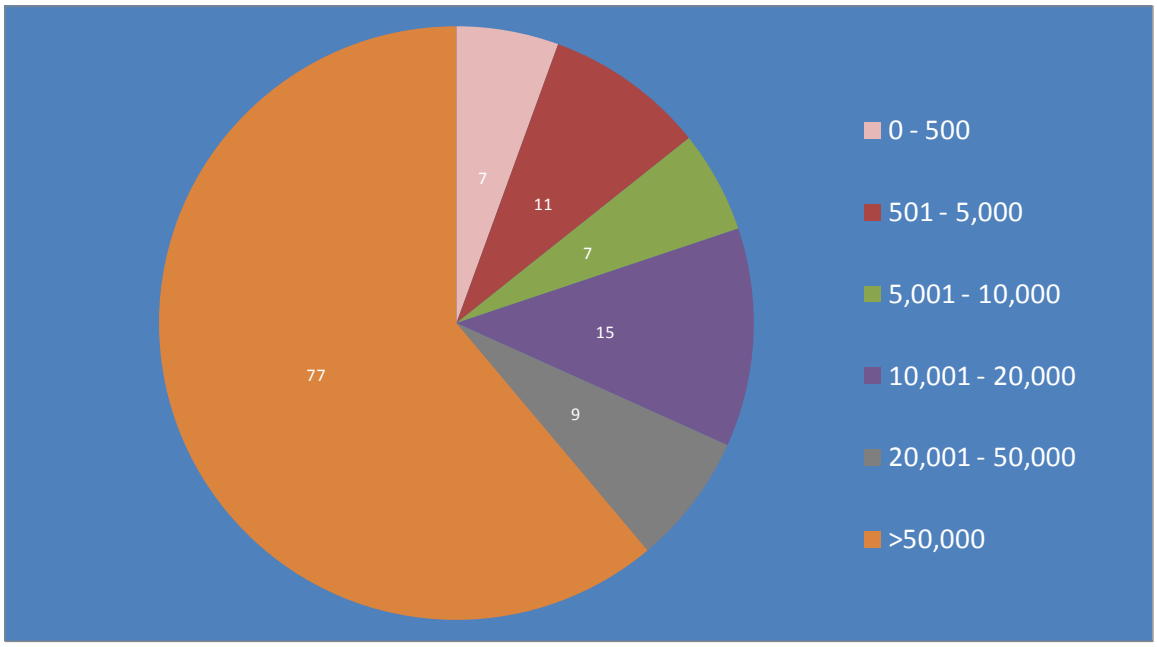
- The vast majority of the plans surveyed were U.S. plans.
- Plans were mostly qualified pension plans.
- Over half the plans surveyed were open to ongoing accruals. Most plans were public entities (not to be confused with public sector plans). These plans are sponsored by Securities and Exchange Commission registrants.
- Most plans reported were non-contributory, non-multi-employer and non-multiple-employer. By extension, we can conclude the majority of the plans reported are single employer plans.

Figure 2 - Breakdown of Non-Public Sector Plans by Participant Count (134)



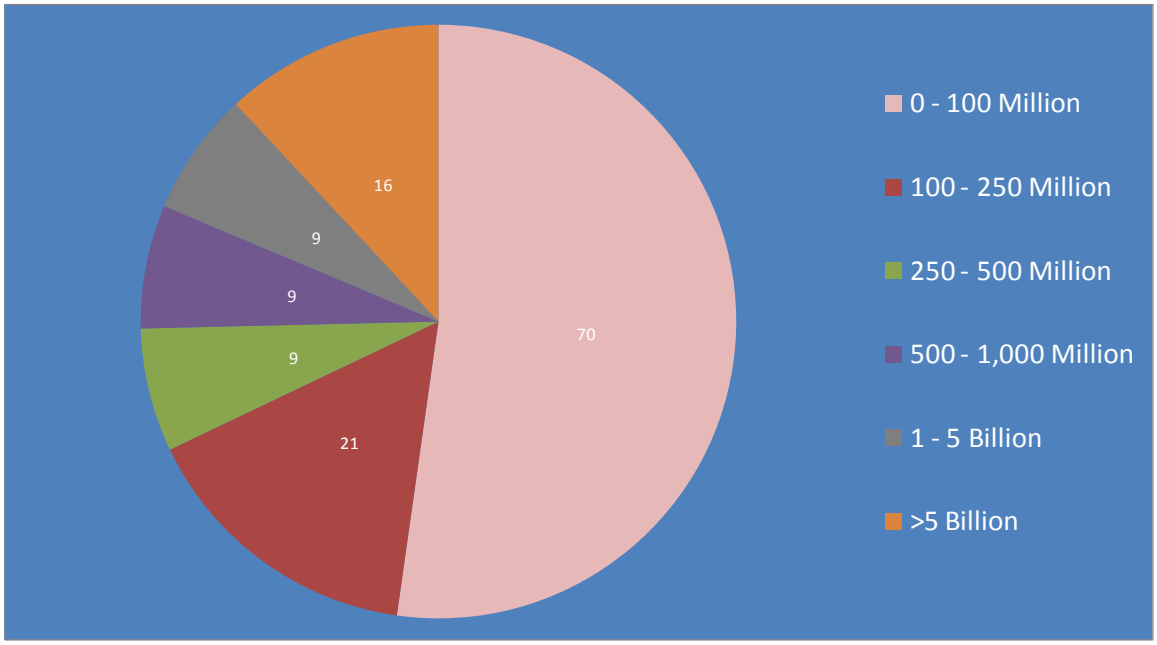
Participant count was spread between the six categories. Two-thirds of the plans reported had fewer than 5,000 participants.

Figure 3 - Breakdown of Public Sector Plans by Participant Count (126)



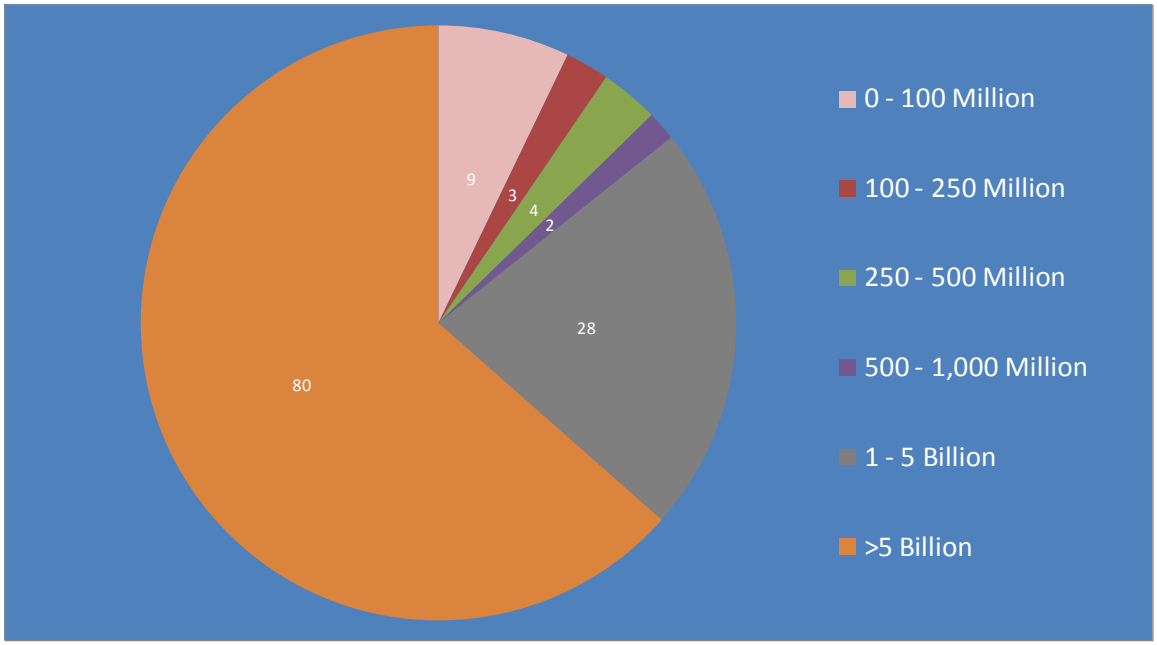
For public sector plans, 61% had greater than 50,000 participants. The other 31% of the plans were spread fairly evenly among the other participant count buckets.

Figure 4 - Breakdown of Non-Public Sector Plans by Assets (134)



A little more than half of the plans surveyed had fewer than $100 million in assets. This corresponds to the low participant count of these plans. By contrast, 86% of the Public Sector Systems have over $1 billion in assets.

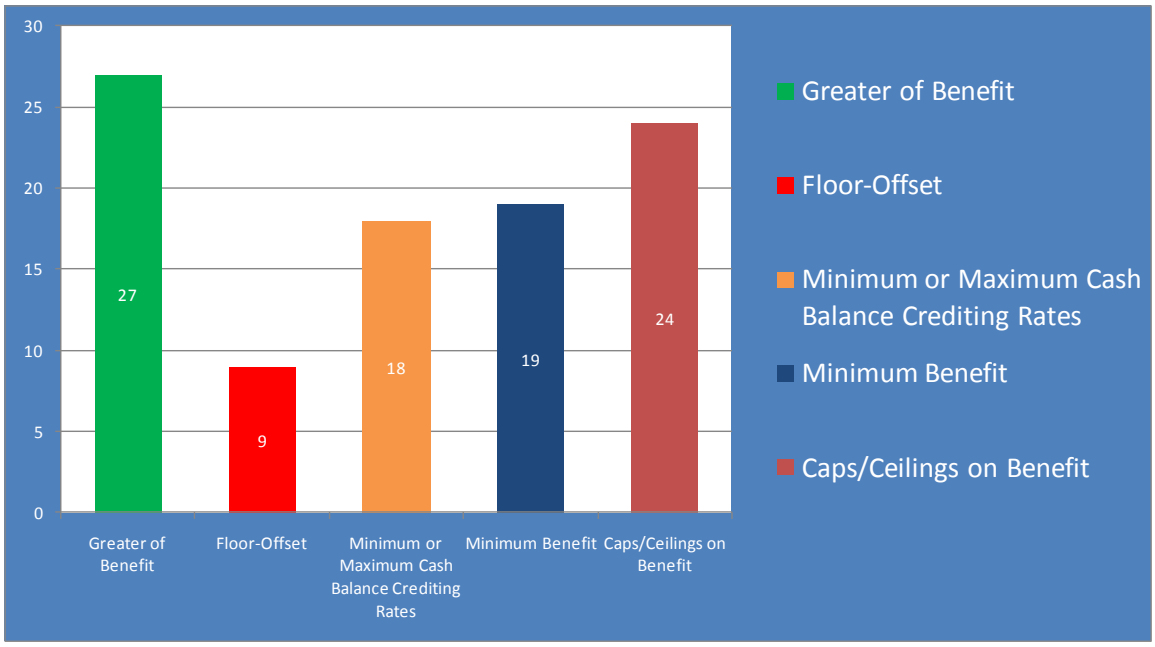
Figure 5 - Breakdown of Public Sector Plans by Assets (126)



For public sector plans, 86% had over $1 billion in assets.

b) Breakdown of Embedded Options - Figures 6-12

Figure 6 - Breakdown of Category 2 Embedded Option Totals (Non-Public)



The most prevalent Category 2 option (in terms of number of times it appeared as an option) in private sector plans is: greater of benefit (27 times this option appeared as a feature of the pension plan). Caps/ceilings and minimum benefit were a close second (24 and 19 appearances, respectively).

Figure 7 - Breakdown of Category 2 Embedded Option Totals by Industry (Public and Non-Public Sector)

	Plan Count	Total Embedded Options		Plan Count	Total Embedded Options
Aerospace & defense	8	16	Hospitality & leisure	0	0
Automotive	0	0	Insurance	12	6
Banking & capital markets	6	1	Investment management (alternative instruments)	2	0
Chemicals	10	3	Law firms	12	5
Communications	1	0	Manufacturing	9	5
Consumer Finance	0	0	Metals	3	0
Educational & other nonprofit	9	7	Public Sector Systems	126	45
Energy, utilities & mining	14	11	Real estate	0	0
Engineering & construction	1	0	Retail & consumer	1	0
Entertainment & media	2	2	Services	4	3
Financial services	12	6	Technology	0	0
Food & beverage	9	12	Transportation & logistics	2	0
Forest, paper & packaging	3	2	Wholesale & distribution	3	1
Health industries	7	14	Utilities	4	3
			Total	260	142

Figure 7 illustrates the pervasiveness of embedded options within pension plans. Seventeen of the 23 industries represented in the survey have at least one pension plan with an embedded option. Albeit a small sample size, all industries with more than three respondents contained at least one plan with an embedded option.

An interesting result is that the Aerospace & Defense and Health industries had an embedded option per plan ratio of 2 to 1 according to the respondents of the survey. Generally, these industries have continued to offer defined benefit pension plans to their employees and because of the important role the plans play in providing benefits within these industries, the granting of guarantees or other category 2 options is to be somewhat expected.

Figure 8 - Breakdown of Category 2 Embedded Option Type by Industry - Non-Public Sector Only

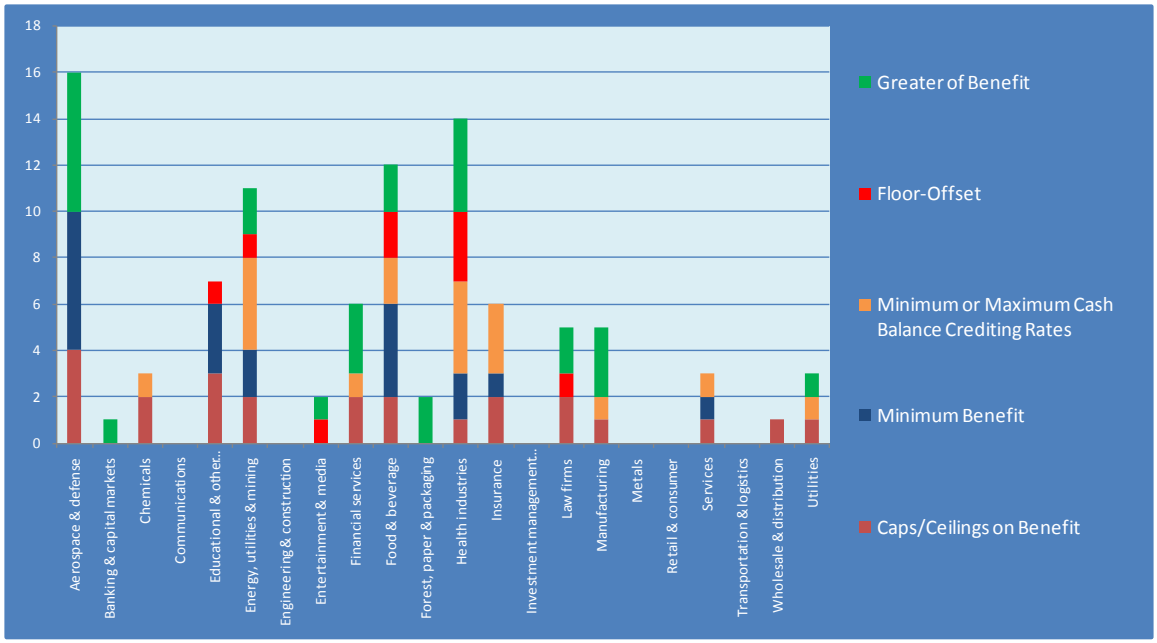


Figure 8 shows the Category 2 options contained within each industry. The Category 2 options are spread out fairly evenly across the industries with greater of benefit and caps/ceilings on benefit being the most prevalent with 27 and 24 instances, respectively.

Figure 9 - Breakdown of Category 2 Embedded Option Type (Public Sector Only)

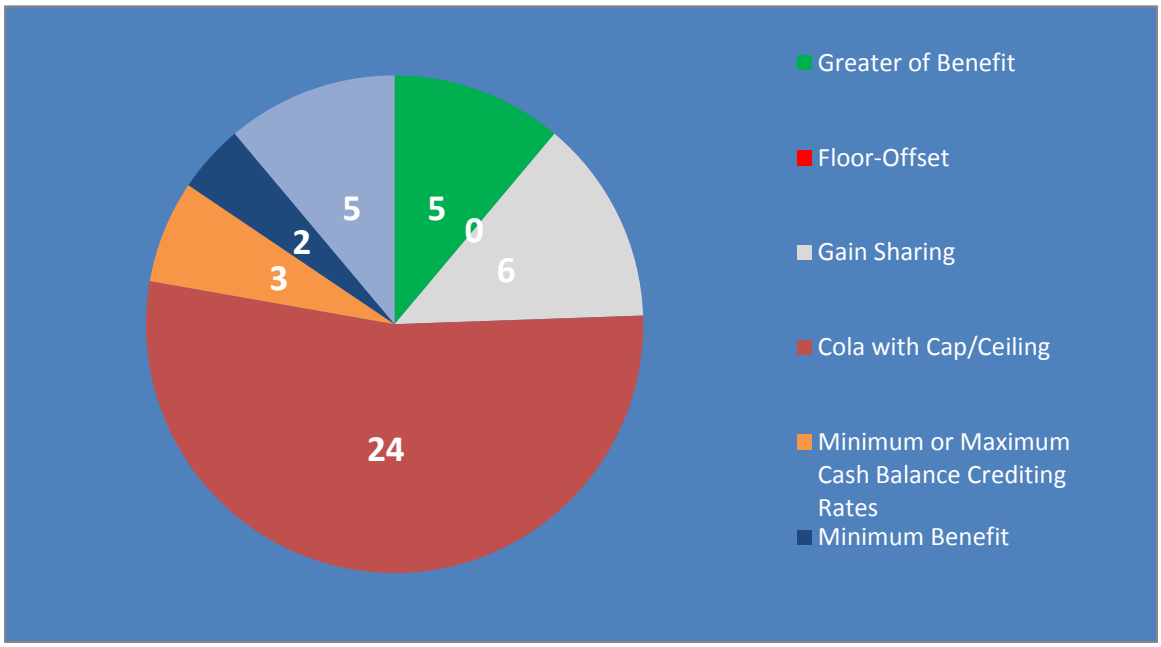


Figure 9 displays the types of embedded options contained within the 126 public sector plans surveyed. It can easily be seen that cost of living adjustments with caps/ceilings dominate the embedded option landscape in public sector plans. These type of plan features represent 64% of the total embedded options contained within the public sector plans surveyed.

Figure 10 - Breakdown of Category 2 Embedded Option Totals by Plan Type - Non-Public Sector Only (134)

Plan Type	Plan Count	Total Embedded Options
Career Average	21	8
Cash Balance	19	24
Final Average	74	56
Flat Dollar	6	1
Variable annuity	8	2
Other (please specify)	6	6
Total	134	97

Figure 10 displays the total embedded options contained within a certain plan type. Final average pay plans represent 55% of the plans surveyed. On a per plan basis, it appears that cash balance plans contain the most Category 2 embedded options. We did not include a public sector plan figure that breaks down Category 2 embedded options by plan type because 97% of the plans surveyed were final average pay.

Figure 11 - Category 2 Embedded Option Breakdown by Plan Type (Without Final Average Pay)

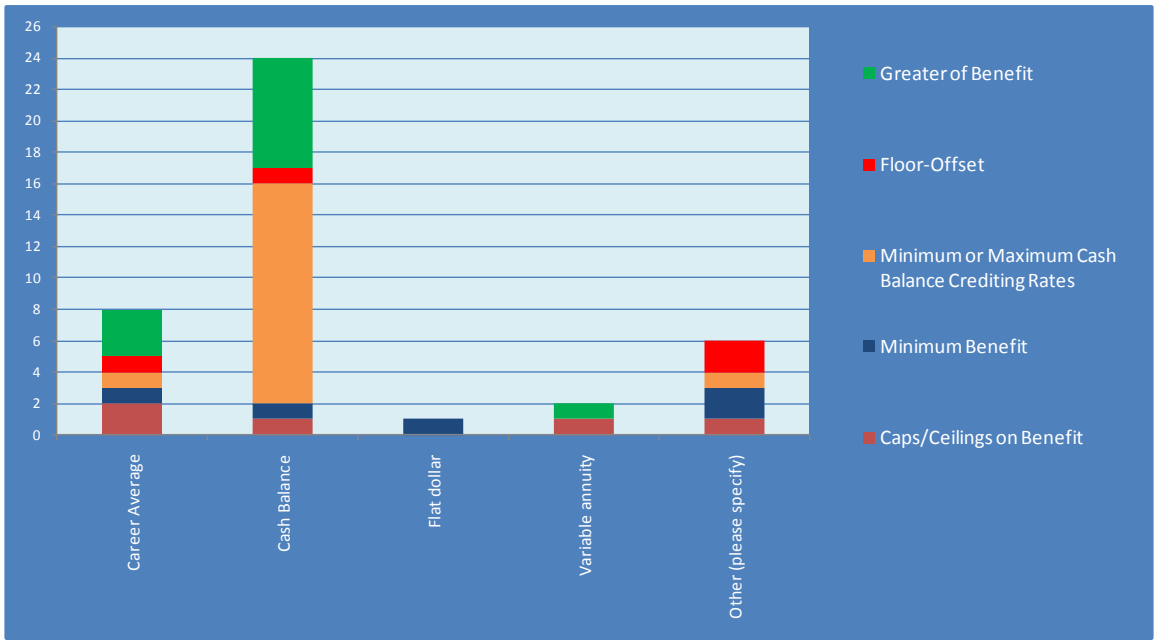
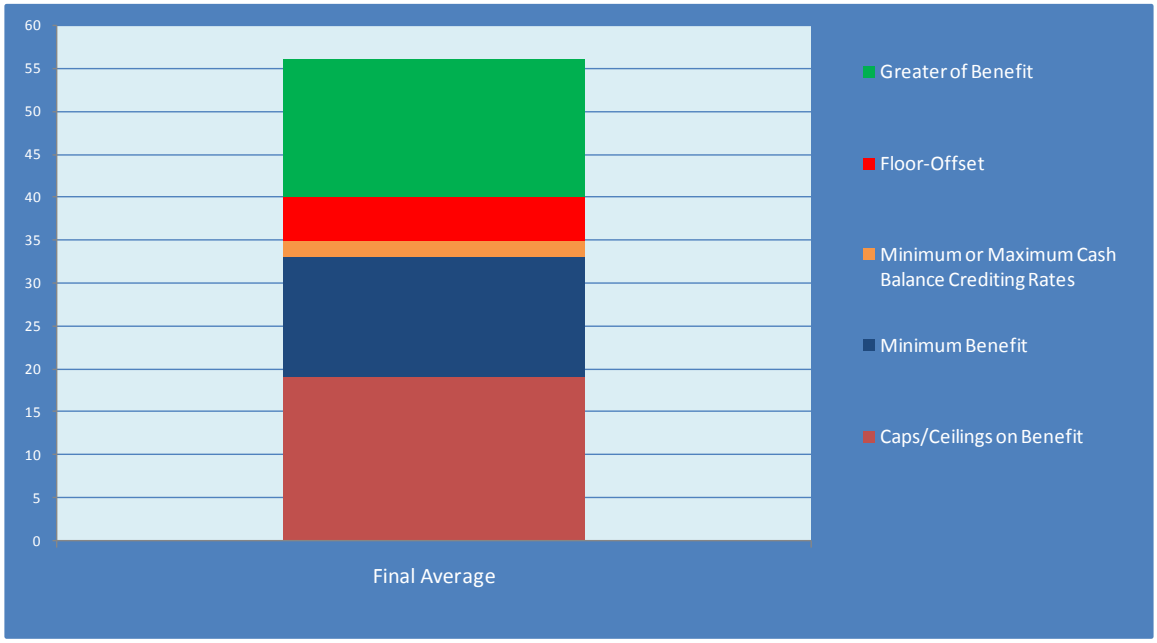


Figure 11[19] shows the breakdown of total embedded options within each plan type. This graph excludes final average pay plans. This approach was taken to avoid final average pay plans from significantly skewing the graph.

[19] Note two somewhat peculiar survey responses: the minimum or maximum cash balance crediting rate contained within the career average plan type and the cash balance plan with a floor-offset option. This is very likely a survey input error by a respondent.

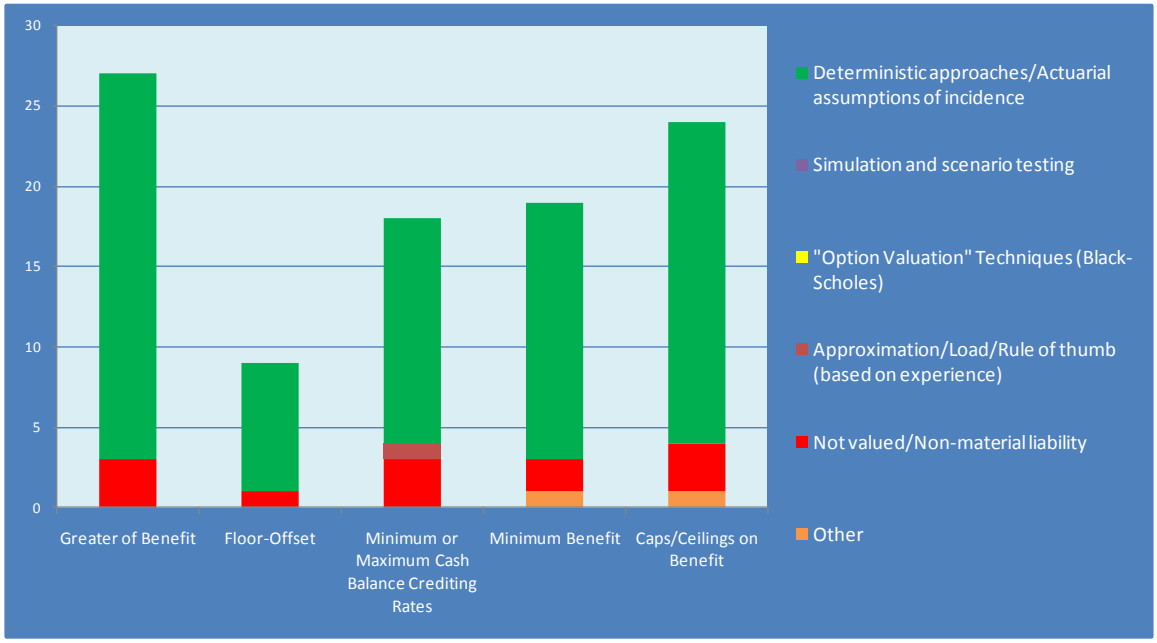
Figure 12 - Breakdown of Category 2 Embedded Options by Plan Type (Final Average Pay Only)



The embedded option counts are broken down for final average plans in Figure 12. Greater of benefit and caps/ceilings on benefit options represent the majority of the embedded options within the surveyed plans.

c) Breakdown of Embedded Option Valuation Method - Figures 13-15

Figure 13 - Breakdown of Category 2 Embedded Options by Valuation Method



The second objective in conducting the survey was to determine how Category 2 embedded options were being valued by plan actuaries. The results show that the majority of these options are valued using best-estimate deterministic assumptions. It does not appear that "Option Valuation" techniques or simulation and scenario testing are being used to value these options.

We could not obtain the necessary information to determine how plan actuaries were valuing embedded options for the public sector systems. This information is not available in the public domain.

In order to get a better understanding of how public sector actuaries were valuing embedded options, SOA staff emailed select public sector actuaries to solicit information. Responses were very limited with only one indicating the valuation approach used.

The plan in question provided COLA increases as follows: COLAs are tied to annual changes in CPI, but capped at 3% per year. The plan also has a provision where past changes in the CPI above 3% are available to cover periods where the CPI falls below 3% (calculated separately by year of retirement).

Two plans used to have a “gain-sharing” COLA, although legislation removed the provision in 2007.

The response indicated that for COLA with a cap of 3%, a deterministic approach is used where COLA is simply valued at 3% per annum, whereas the long term inflation assumption is 3.5%. The respondent noted that stochastic methods are used when pricing specific changes to the COLA. The reply indicated that recently proposed legislation that would prohibit negative COLAs was evaluated using stochastic methods.

With respect to the “gain-sharing” provision, the respondent indicated that stochastic and deterministic approaches were used. Stochastic analysis was used to estimate the reduction in the assumed rate of return due to gain-sharing.

Figure 14 - Breakdown of Category 1 Embedded Options by Valuation Method

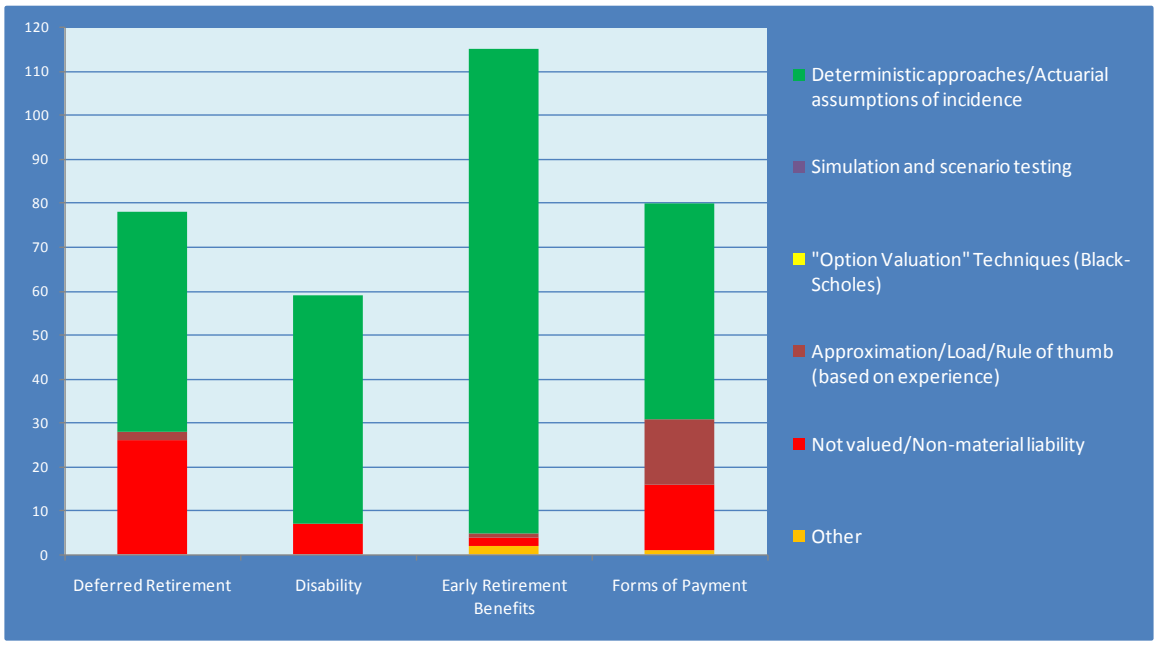


Figure 14 is included to show the similarity in the way actuaries value Category 1 and Category 2 options. There were no survey respondents that use "Option Valuation" Techniques or Simulation and scenario testing. This is the same result as for Category 2 options. We are not particularly surprised by this result as Category 1 options are the more traditionally valued options by actuaries. Best estimate deterministic assumptions are usually reasonable for these types of assumptions due to the Central Limit Theorem and Law of Large Numbers. It is logical that the valuation methods of Category 1 options would be extended to Category 2 options due to the familiarity actuaries have with these techniques, however these techniques likely understate the risk and value of the embedded option.

Figure 15 - Are Category 2 Options Valued the Same for Funding and Accounting Purposes?

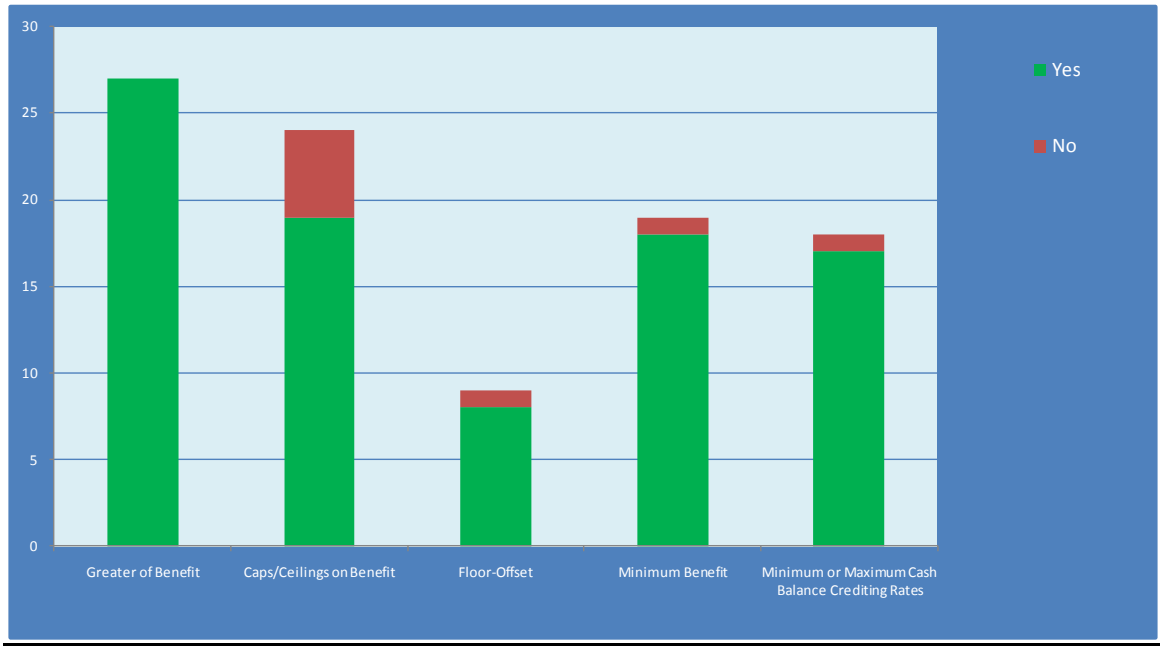


Figure 15 illustrates that the overwhelming majority of plan actuaries (92%) value Category 2 embedded options contained in pension plans the same for both accounting and funding purposes. It is not clear from the survey results why the remaining 8% of plan actuaries value the options differently for the two purposes or how the valuation methods differ. Because we saw from figure 13, that the overwhelming majority value embedded options by deterministic methods, it is likely the difference here is either that the option is valued for one purpose and not the other or that the assumptions used to value the option are different (for example, the discount rate due to mandated differences required under U.S. pension funding and accounting rules).

Figure 16 - Has There Been a Change to the Valuation Method Given Recent Market Events?

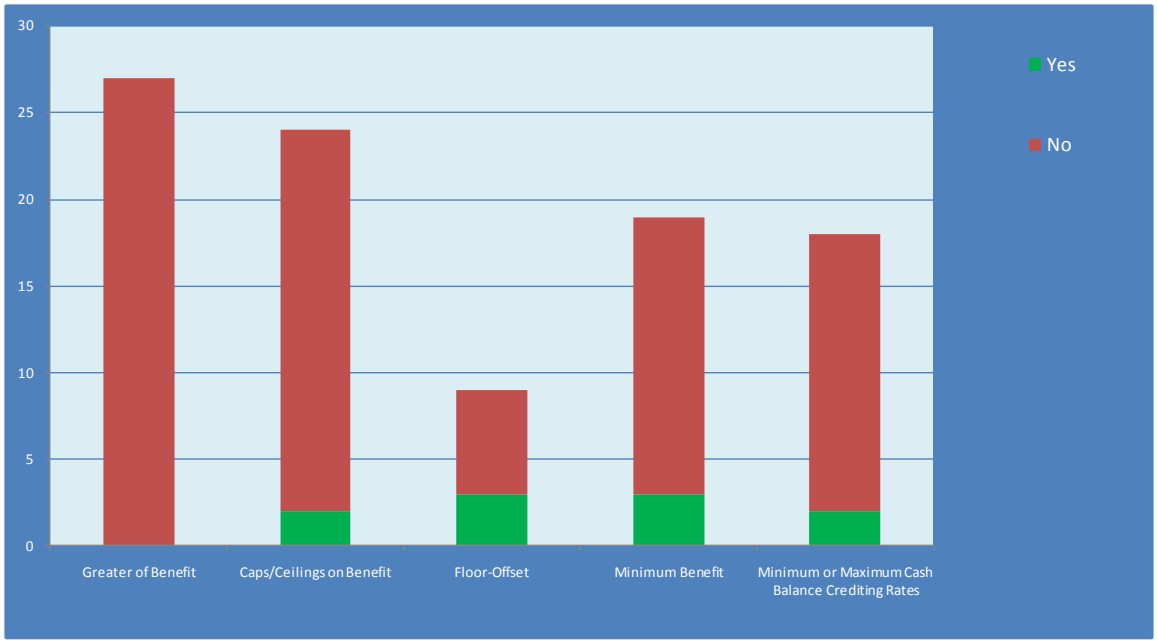


Figure 16 illustrates that the overwhelming majority of plan actuaries (90%) continue to value the embedded options contained in pension plans the same as they have been prior to the recent market turmoil. We were unable to obtain information on what the other 10% of actuaries have done. It is quite evident from the data that recent market and economic conditions have not prompted widespread changes in actuarial valuation methods. This is noteworthy because many of these options lead to large cost increases for plan sponsors under these environments.

F. Survey limitations

- Like all surveys, the results stated herein are predicated on receiving credible responses. While some of the replies were provided by PwC practitioners where we had the opportunity to ask follow-up questions, many responses were provided anonymously and therefore did not lend themselves to further inquiry. As we have noted in this report, we did identify a few places where results appeared spurious. These incidents were minor.

- We were not able to obtain information on how public sector plans value their embedded options. As we discussed earlier, embedded option information for the public sector was culled from the websites of the various governments. Information available online did not offer a window into the techniques and methods used to value embedded option features prevalent in public sector plans. From some brief conversations we had with actuaries practicing in the public sector, we are aware that some actuaries do use stochastic simulations to evaluate the cost of embedded options.

- For private sector plans that granted cost of living adjustments, we were unable to determine if the adjustments were subject to cap or floor provisions. As a result, we removed that option from the graphs.

Conclusions

Survey results show that Category 2 embedded options are fairly prevalent in private sector pension plans. In the public sector, cost of living adjustments with caps and/or floors are common features.

For the most part, to value embedded option plan terms, actuaries are either altogether ignoring the feature or using deterministic assumptions. Both of these approaches do not reflect the true risk or value of these terms of the pension plan.

Part II of this research will offer an introduction into techniques that actuaries can use to value Category 2 embedded options.

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