

AARP Public Policy Institute



Hybrids and Other Alternatives to the Traditional Pension

Sandy Mackenzie
AARP Public Policy Institute

Research Report



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AARP Public Policy Institute
601 E Street, NW, Washington, DC 20049
<http://www.aarp.org/ppi>

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EXECUTIVE SUMMARY

The decline of the traditional defined benefit (DB) plan and the rise of 401(k) and other defined contribution (DC) plans may be jeopardizing retirement security. The 401(k) plan has valuable features, but compared with a traditional pension, it suffers from important shortcomings. Because contributions are voluntary, the shortsighted may save too little; foolish or unlucky investment decisions could further reduce the retirement nest egg; and a lack of longevity insurance risks its premature exhaustion. In addition, a 401(k) plan participant must decide how rapidly to draw down his or her balance, which is no mean feat. Nonetheless, this report finds that financial instruments can make a 401(k) plan, or even an individual retirement account (IRA), mimic a traditional pension and mitigate the 401(k) plan's weaknesses.

The report evaluates alternatives to the 401(k) plan and other DC plans. It examines several hybrid plans that have characteristics of both DC and DB plans: the cash balance plan, the pension equity plan, and the so-called DB(k) plan, which combines a traditional plan with a 401(k) plan. The first two plans mitigate the risk of saving too little but not longevity risk, while the third mitigates both risks to some degree.

The report then examines two 401(k) add-ons: the first grafts a variable annuity onto a 401(k) plan; the second turns a 401(k) plan into a deferred annuity. Both these instruments address longevity risk, although they do not ensure that saving, which remains voluntary, will be adequate. Experience with the 401(k) add-ons is limited, and more needs to be known to form a definitive assessment. Nonetheless, these plans and the DB(k), if their coverage grows, could enhance the retirement security that the 401(k) plan provides. Finally, given the importance of increased annuitization, the report briefly reviews a number of policies to improve the functioning of the annuity market, including automatic annuitization, the introduction of longevity bonds and longer maturities on conventional bonds, and improved financial education.

INTRODUCTION

The coverage rate of all U.S. employer-provided plans has remained remarkably constant over the past three decades: at any given time, about 50 percent of the workforce has participated in some type of plan. This constancy, however, has hidden a disconcertingly large slide in the coverage of traditional pensions. Specifically, the share of workers covered under their current job by a defined benefit final or average salary pension has fallen from 32 percent in 1989 to 17 percent in 2007. Whether or not the decline of the traditional pension will bottom out, it is not likely to make a strong comeback.

The decline in the coverage of the traditional pension almost certainly has jeopardized the security of retirement for many older Americans. Even if we rule out the risk of inadequate lifetime income because of poor labor market conditions or disability, three principal risks to a secure retirement remain: the risk of insufficient saving during working life, the risk of underperforming financial markets or ill-considered investment decisions, and the risk that retiree's next egg will be exhausted. The traditional pension, despite a bias against short-tenured workers, provides good protection against all three risks for long-tenured workers. There is real reason to be concerned that the 401(k) plans that have replaced the traditional plan do not provide this protection.

This report is particularly concerned with the adequacy of the longevity insurance that alternatives to the traditional pension provide, because the postretirement lifetime income that a traditional pension provides is such a special and important feature. A key feature of most defined contribution and hybrid plans is that plan members must manage a series of phased withdrawals: the plans' balances are almost invariably distributed as a lump sum.¹ The decline of the traditional pension will increase the share of distributions that take this form. This report is also concerned about the ability of alternatives to the traditional pension to mitigate the risks of insufficient saving and of poorly performing investments.

The report is organized as follows. The first section reviews the basic properties of cash balance plans and other hybrids and their ability to address the three identified risks to retirement security. Hybrid plans' approach to risk is contrasted with that of 401(k) and other defined contribution plans. The second section considers the consequences of reliance on a phased withdrawal strategy. This section relies on a simple model of investment and Monte Carlo simulations to show why managing a phased withdrawals program is not easy. The third section describes and analyzes two add-ons to 401(k) plans that endow them with certain features of the traditional plan, again relying on Monte Carlo simulations to shed light on how effectively they replicate features of the traditional pension. The concluding section summarizes the report's main findings and sets out policy recommendations. The appendix covers some of the technical aspects concerning alternatives to the traditional pension.

¹ Of employers offering a 401(k) plan and surveyed by Hewitt Associates, only 15 percent offered an annuity option, and only 6 percent of retirees who were offered that option chose to take it (EBRI 2008).

HYBRID PENSIONS

Hybrid pensions are pensions that are legally classified as defined benefit (DB) plans but that have the characteristics of both DB and defined contribution (DC) plans. (See box 1 for a pension plan glossary.)

Box 1. Pension Plan Glossary

401(k) plan—a type of employer-provided defined contribution plan, participation in which is not a condition of employment. The employer sets the maximum but not the minimum contribution rate, subject to the limits the IRS imposes on contributions. Employers typically provide a matching contribution up to some specified percentage of salary, usually 3 percentage points. Contributions to 401(k) plans may be deducted from taxable income in the year they are made and are taxed in the year in which they are withdrawn. The accumulated balance is almost always withdrawn in a lump sum.

Cash balance plan—see *Defined benefit pension*.

Defined benefit pension—an employer-provided pension plan with a benefit that is determined by the terms of the plan. DB pensions can take many forms. The traditional form is a final salary plan, where the pension is determined by the number of years of plan service and end-career salary. For full-time workers, participation in a DB plan is normally a condition of employment. A cash balance plan is technically a DB plan because the benefit is determined by the rate of contribution, which the plan sets, and the normally fixed rate of interest applied to plan member balances. See also *Hybrid pension*.

Defined contribution pension—a pension plan that determines the contributions that members pay, but not the benefit they receive. A typical employer-provided DC plan specifies a contribution rate as a proportion of salary. With some DC plans members have no say in how the funds are invested, but in most plans investments are self-directed.

Hybrid pension—a pension plan that has features of both DB and DC plans, but is legally a DB plan. A cash balance plan resembles a DC plan because it has a balance, and the benefit is normally in lump-sum, not annuitized form.

Most of the growth in the coverage of hybrid plans has resulted from conversions of traditional DB plans, rather than the creation of new plans or a move away from DC plans. Pension Benefit Guarantee Corporation (PBGC) data show that, statistically, most of the decline since 2001 in the number of workers covered by the traditional pension has been offset by the increase in the coverage of hybrid plans (see table 1). In 2007, some 3 in 10 workers in single-employer plans insured by the PBGC participated in hybrid plans, up from 2 in 10 in only six years.

Start of Year	Participants			Share of Hybrids (in percent)
	In All Plans	In Hybrids (in thousands)	In Other Plans	
2001	34,342	7,034	27,308	20.5
2002	34,248	7,915	26,333	23.1
2003	34,207	8,475	25,732	24.8
2004	34,523	9,993	24,530	28.9
2005	34,232	10,333	23,899	30.2
2006	33,933	10,285	23,648	30.3
2007	33,892	10,950	22,942	32.3

Source: PBGC 2008, table S-35.

Commentators have advanced various explanations for the conversion phenomenon. These explanations include (1) the desire of plan sponsors to avoid the reversion taxes that are triggered by the termination of a DB plan or by transfers of assets in excess of funding requirements from a plan to its sponsoring corporation; (2) the greater predictability of the funding requirements of hybrid plans; and (3) in the case of many conversions, the reduction in plan cost.² Another advantage from the employer's perspective is that hybrid plans reduce the investment risk borne by the plan sponsor.

CASH BALANCE PLANS

The cash balance (CB) plan has been aptly described by McGill et al. (2005, 310) as “a defined benefit plan that looks and feels like a defined contribution plan.” Unlike DC plans, the balance in a CB plan grows according to a formula, in which a notional or hypothetical account balance is fed by “pay credits”—usually a fixed percentage of salary that may increase with years of service—to which interest is credited. The interest rate may be constant or may be linked to the rate on Treasury bills or a similar financial instrument.

To understand how a CB plan determines members' benefits, it is helpful to think of the plan balance at retirement as the equivalent of the sum of the pay credits made each year of a plan participant's career, accumulated forward at the plan's rate of interest until retirement begins. The pay credit for a given year will reach a sum by retirement that is determined by its initial value, the number of years that have elapsed since the credit was earned, and the average interest rate applied to the balance. The appendix sets out a more precise expression of this relationship.

Differences and similarities between CB plans and the typical DC plan. The CB plan does resemble a DC plan, in that the amount accumulated over a worker's tenure depends on the length of that tenure, the average contribution, and the average rate of return to contributions. Nonetheless, the implicit return to contributions to a CB plan is either fixed or less variable than the return to the typical 401(k) plan, and its sponsor is responsible for funding the plan. This is an important feature of CB plans, because it relieves the plan member of investment risk.

The degree of risk this responsibility imposes on the plan sponsor depends on how the interest rate that applies to pay credits is set. The plan sponsor assumes no investment risk if the rate of interest is set equal to some short-term market-determined rate, because the sponsor can hedge any risk by investing all of the plan's balances in the short-term security. When the rate of interest is fixed, then in principle it is exposed to some investment risk, although in practice this risk can be contained by setting the rate relatively low.

Another significant difference between a CB or other hybrid plan and the typical 401(k)-type plan is that the contribution rates of the former are fixed (unlike a 401(k) plan, there are no employer matches), and participation in the plan is usually a condition of employment. These two conditions do not apply to a 401(k) plan.

² Reversion taxes are due when part of the surplus (net assets) of a pension plan is transferred back to the books of the sponsoring company. Clark and Schieber (2004) dispute the claim that avoiding taxes was a factor in boosting the number of conversions, but see Ippolito (2004).

Differences between a CB plan and a traditional DB plan. Although both the CB plan and the traditional pension plan are DB plans, important differences remain between them from both the plan members' and sponsor's points of view. By far the most important is that the sponsor of a CB plan assumes no longevity risk. Longevity risk is borne entirely by the plan's participants.

Several other features distinguish the CB from the traditional pension plan. First, as the preceding discussion implies, CB plans can be designed to strictly limit the degree of investment risk that the sponsor assumes, and the related risk of underfunding. Second, the liabilities of a CB plan should be more predictable than those of a traditional DB plan, in that they are less influenced by the workforce's age and length of service.³ These features add to the CB plan's appeal to employers. Finally, even if the balance accumulated in a CB plan is not transferable to another employer's plan when an employee separates, the balance continues to accrue interest, unlike the typical DB plan (see figure 1).⁴ This feature makes the CB plan more appealing to employees. In these respects, the CB plan is more like a DC plan than a DB plan. Traditional DB plans assign the major retirement risks to the plan sponsor, but this is not an *inherent* feature of a DB plan, particularly when the benefit assumes the form of a lump sum upon retirement or separation.^{5,6}

PENSION EQUITY PLANS

The Pension Equity Plan (PEP) is a cousin of the CB plan. Speaking very roughly, the PEP is to the CB plan what the final salary plan is to the career average plan. The main difference between the two plans is the heavy weight that the PEP gives to end-career salary in calculating the benefit. To determine the benefit per year of work, the PEP applies an accrual factor to the participant's average salary over a short period (three to five years) just before retirement.⁷ The benefit paid, which is a lump sum, is then determined by multiplying the resulting figure by the number of years worked. There is no interest rate to produce a compounding effect, but the choice of the final salary rather than an average salary has an effect similar to compounding. The appendix provides a more formal expression of this relationship.

³ Strictly, speaking, this depends on whether the pay credit increases with years of service. If it does not, the departure of one worker and his or her replacement by another at the same salary should have no effect on plan liabilities. The present value of the accrued liabilities on past service is not altered by unexpected increases in average service time in these circumstances.

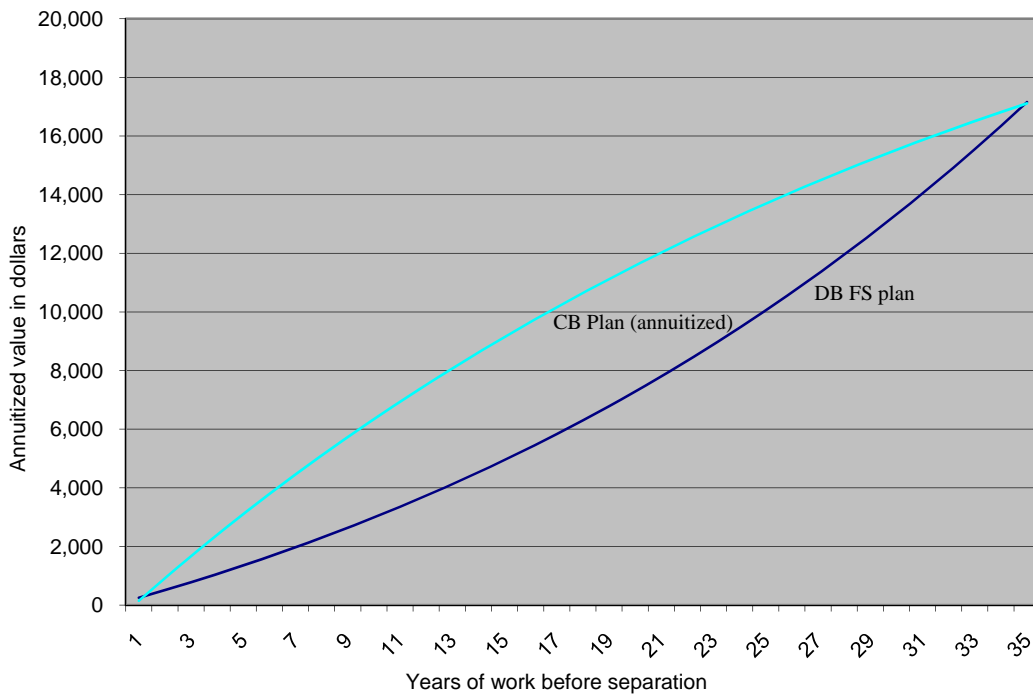
⁴ With the typical final salary plan, the accrued benefit of a worker who separates before retirement remains fixed in nominal terms. In figure 1, the two plans shown have been set to produce the same benefit at retirement, assuming the worker does not separate before retirement. Salary grows by 2.5 percent per year, the pay credit percentage of the CB plan is 7.3 percent, and the rate of accrual of the final salary plan is 1.3 percent. Finally, the interest rate that applies to CB plan balances is 5 percent.

⁵ An additional selling point for employees could be the apparently superior transparency of CB plans, which results from the regular reporting of the balance accumulated to date. This advantage may be more apparent than real. Comparing the current balance of a CB plan with the conditionally predicted benefit of a DB pension is like comparing apples with oranges. Knowing the current balance of a participant's plan (a stock) does not allow the participant to convert it into a sustainable income flow.

⁶ In the past, the conversion of traditional pensions to CB plans has raised concerns that older workers would be disadvantaged. However, the *Employee Retirement Income Security Act of 1974* (ERISA) requires that a plan member receive the benefit he or she would have received under the old plan as long as it exceeds that of the new.

⁷ For the employee separating early, the benefit is determined by applying the accrual factor to the average salary earned in his or her last years on the job and then indexing the result to an interest rate until the employee is eligible to take distributions.

Figure 1
Comparison of Value at Retirement with Value at
Early Separation of a CB Plan and a Traditional DB Plan



Note: CB = cash benefit; DB = defined benefit; FS = final salary.

Source: Author's model and calculations.

A third type of plan, which was introduced by the Pension Protection Act of 2006 (ERISA § 210d) and has come to be known as the DB(k), combines features of DB and DC plans by including a DC plan with a traditional DB plan. The DB(k) plan is aimed at the small employer. The employer entirely funds the DB plan, and except for employer matches, the employee funds the DC plan (the 401(k)). The DB plan must be able to pay a worker a pension of 1 percent of final salary per year of service up to 20 years. The employee's contribution to the 401(k) plan is set automatically at 4 percent of salary—although the employee may opt out—and employers must match at least 50 percent of the employee's contribution up to 4 percentage points. The combined plan has the virtue of reducing the cost of the DB component below that of the typical plan, while still providing employees with more longevity insurance than they would have with only a 401(k) plan. It also reduces the risk of undersaving and poorly performing investments.

HYBRID PLANS AND RETIREMENT SECURITY RISKS

Both the CB plan and the PEP mitigate the risk of inadequate saving, because they automatically enroll plan participants and fix the pay credit percentage, the interest rate, or (in the case of the PEP) the accrual factor. Hybrid plans also mitigate the risk of poor investment returns, because the choice of a Treasury-related rate reduces investment risk below that of a self-directed DC plan with an aggressive asset allocation. This low investment risk, however, comes at the cost of mediocre investment returns.

The main shortcoming of both plans is that neither deals with longevity risk. Annuitization is a required *option* with a CB plan or PEP, as it is with a traditional pension, but the premium per dollar (the annuitization factor) can vary substantially from year to year. Adverse selection may be an issue, because annuitization is only one option and plan members opting for it may be long-lived. The effect of this variability on annuity income can be somewhat offset by buying annuities in installments and by replicating the immunizing portfolio strategies of insurance companies. These strategies are relatively sophisticated, however, and they may be costly for plan members with small balances. In any event, the annuitization option is not popular.

Until regulations governing DB(k) plans have been finalized, probably sometime in 2010, employers cannot adopt these plans. Nonetheless, this option could be more attractive than the traditional pension or a standard 401(k) by itself.

THE DO-IT-YOURSELF APPROACH TO STEADY INCOME AND LONGEVITY INSURANCE

The shift toward hybrid and DC plans and away from traditional DB pensions means that an increasing number of workers will retire without an annuity from an employer-provided pension. Retirees without an annuity whose Social Security benefit does not provide an adequate replacement rate may well lack adequate longevity insurance. Such retirees will need to purchase an annuity or figure out how to manage their savings to last their lifetime.

To manage savings well, retirees must deal with two different problems. First, they must manage their capital to generate a reasonably steady income over time. Second, they must try to ensure that their capital will not run out before they die. In other words, retirees must self-insure against longevity risk. In the next few pages, we first consider the pitfalls that arise with efforts to generate sustained income in retirement when annuitization of a substantial share of wealth at retirement is not a desirable option. The discussion concentrates on the problem of maintaining steady income over a specified period rather than on the consequences of longevity risk. We then briefly discuss homemade solutions to longevity risk and consider how a DC plan or hybrid plan can be augmented to deal with longevity risk.

Even if retirement life span were completely predictable, maintaining a steady income would be no mean feat. Retirees need to adopt a strategy, or at least apply a rule of thumb, that determines the rate at which they make withdrawals to finance household expenditures. Although most people might not draw up a formal withdrawal plan, we will evaluate four different phased withdrawal rules using Monte Carlo simulation experiments to capture the effect of the uncertain rates of return on the assets in which a retired person's capital is held.⁸ The retired person's assets are assumed to be invested in two funds, one composed of large capitalization stocks and the other composed of long-term government bonds. The initial proportion of stocks and bonds is maintained by rebalancing the portfolio each year. Portfolio management fees amount to 1 percent of capital. Other assumptions are set out in box 2. All experiments assume that the retiree, who stop[s] work at age 65, starts with \$500,000. We assume that retirees live until age

⁸ The approach taken here is similar to that of Webb (2009).

Box 2. Assumptions Used in Monte Carlo Simulations of Four Phased Withdrawal Strategies*Stochastic variables*

Financial performance*

Rates of return (in percent in real terms)

Large cap	9.0
Long-term bonds	2.8

Standard deviation (in percent)

Large cap	20.1
Long-term bonds	10.3

Parameters

Initial balance	\$500,000
Equity-bond mix	50-50
Initial withdrawal rate (except for Rule 3)	5 percent of capital
Marginal and average tax rate	15 percent
Fees (covering all services)	1 percent of capital

* The distribution of returns is assumed to be lognormal (i.e., with the return denoted by r , $\log(1+r)$ is a normally distributed random variable). The rates of return and standard deviations are based on the performance of U.S. stocks and long-term government bonds over 1929–2007. The estimates are based on a run of 1,000 simulations.

Sources: Morningstar 2008. Life expectancies are derived from SSA (2002).

90—by no means an advanced age these days. This allows us to focus on investment risk.⁹

Under the first rule, annual withdrawals are initially set at a particular level (for example, \$25,000) and maintained at that level in real terms until the end of the retirement period or asset exhaustion, whichever comes first.¹⁰ Under the second rule, withdrawals are maintained at a constant proportion (5 percent) of the value of the portfolio. Under the third rule, withdrawals each year are equal to the account balance divided by the remaining years of life expectancy. The fourth rule is a more sophisticated version of the second. Under this rule, the rate of withdrawal, initially 5 percent of the account balance,

⁹ There is an extensive literature on the problem of making the nest egg last (achieving sustainable withdrawals). To give just two examples, Guyton and Klinger (2006) report on simulation experiments conducted to determine what asset allocation strategy yields the largest sustainable flow, while Ameriks, Veres, and Warshawsky (2001) assess the role of partial annuitization of the nest egg in achieving sustainable income flows. This report is not concerned with the problem of maximizing sustainable withdrawals, but with contrasting the effects of different phased withdrawal rules and the 401(k) add-ons on income variability.

¹⁰ The value of the initial balance and the initial withdrawal are chosen for the sake of illustration. They have no particular significance.

is adjusted when the balance diverges from a specified benchmark, increasing when the actual account balance exceeds the benchmark, and vice versa. The retiree sets the benchmark balance, which is expected to decline with age.¹¹ This benchmark represents the minimum balance a retiree would wish to maintain during the retirement period (see box 3, which summarizes the four rules). All monetary values are expressed in real terms (2009 dollars).

None of the four do-it-yourself phased withdrawal strategies can consistently generate both a steady or a guaranteed minimum income and a predictable final balance, which should be greater than zero if the retiree wants to leave a bequest. If income is to be kept steady or a minimum level guaranteed, the final balance will vary hugely. The fourth rule, however, is more successful than the others in avoiding the extremes of a high final balance and a plummeting standard of living in later years.¹²

Rule 1 achieves the smallest variance in withdrawals, and thus variance of expenditure of the four rules, and will achieve constant withdrawals throughout the 25 years from age 66 to age 90 for 75 percent of the time. Following Rule 1 will exhaust the account before the 25 years are up 25 percent of the time, however, and leave the retiree severely deprived if not destitute (see table 2). At the same time, however, the chances that a retiree will die with a large positive balance are substantial, because the mean final balance exceeds \$280,000. The reason is that withdrawals are not increased when asset returns are above average.

Under Rule 2, average withdrawals are lower than they are under Rule 1, because declining account balances drastically reduce withdrawals. For example, if the balance falls to \$100,000, withdrawals under Rule 1 stay at \$25,000, whereas under Rule 2 they fall to \$5,000. The balance at age 90 does not climb as high as it does when asset returns are high under Rule 1, because withdrawals eat into part of the appreciation in asset value that takes place during rising markets. The standard deviation of the average withdrawal under Rule 2 is much larger than it is under Rule 1.

Box 3. Four Rules for Phased Withdrawal

- Rule 1. Constant real withdrawals until assets are exhausted.
- Rule 2. Withdrawals set to equal a predetermined share of the account value.
- Rule 3. Withdrawals determined by remaining life expectancy.
- Rule 4. A version of Rule 2 modified to allow higher withdrawals when account balances exceed a specified benchmark, and require lower withdrawals when they fall short of that benchmark.

Source: Author's compilation.

¹¹ This approach is similar to that of Guyton and Klinger (2006) and Webb (2009).

¹² The conventional way of comparing and evaluating different withdrawal or decumulation strategies is to posit an intertemporal utility function that assumes that retirees attach great importance to a stable and durable stream of income and determine which strategy would maximize expected discounted utility. We examine the mean and standard deviation of the stream of income produced on the grounds that it allows a comparison that is more intuitively appealing.

Table 2				
Comparative Performance of the Phased Withdrawal Rules <i>(in thousands of 2009 dollars except where noted)</i>				
	Rule 1	Rule 2	Rule 3	Rule 4
Average Withdrawal				
Mean	24.2	21.8	29.1	29.5
Standard deviation	1.9	5.6	7.5	6.6
Average Final Five Years' Withdrawal				
Mean	21.4	19.2	17.8	26.7
Standard deviation	7.7	8.4	8.3	6.1
Final Balance				
Mean	281.3	369.6	41.9	64.1
Standard deviation	338.0	176.0	22.0	10.2
Probability of exhaustion (in percent)	25	0	0	0

Source: Author's simulation model. For assumptions, see text.

Dropping the annual withdrawal to \$20,000 under Rule 1 reduces the risk of penury but increases the likelihood of large residual account holdings. By dropping the rate to 4 percent of the annual balance under Rule 2, the retiree merely suffers a further decline in average withdrawals, which remain highly variable.

Rule 3 allows retirees to withdraw funds at a rate that would exhaust the current balance (ignoring returns on investment) over the period of their remaining life expectancy. For example, a retiree in his late 70s with a life expectancy of 10 years could withdraw 10 percent of the account balance. The withdrawal rate is adjusted every year to reflect the age-specific decline in life expectancy.¹³

Compared with Rule 1 or Rule 2, average withdrawals under Rule 3 are much higher and end-period balances much lower. This reflects the fact that the initial withdrawal under a life expectancy rule is higher than 5 percent (because a 65-year-old man's life expectancy is estimated to be about 15 years) and continues to grow. When financial returns are above average, the withdrawal is substantially larger than it would be with Rules 1 or 2. The price for these initial fat years, however, is lower withdrawals in the lean years and a substantial drop in withdrawals as the retiree ages.¹⁴

Rule 4 addresses some of the shortcomings of the first three rules by adjusting the withdrawal by a fraction of the difference between the actual account balance and a target or benchmark balance, which declines with age. It allows retirees to spend more when their accounts are comparatively flush and obliges them to make economies when the balances are comparatively low. This strategy raises the average withdrawal, although withdrawals can still fluctuate substantially. The decline in withdrawals late in life is less than it is with Rules 1 through 3 (see table 2). Rule 4 substantially reduces the balance outstanding at age 90 and the variance of the remaining balance. By keeping the actual

¹³ The simulations assume that all retirees live to age 90, but that retirees under Rule 3 do not know how long they will live and adjust their life expectancy as they age.

¹⁴ The risk of such a drop could be reduced by scaling the withdrawals, so that the initial withdrawal will not exceed \$25,000.

balance near its benchmark, Rule 4 reduces the volatility of consumption over the span of retirement, even if a spell of poor investment returns pushes it down.¹⁵

The pronounced volatility of consumption under Rules 1 through 3 is an unavoidable consequence of the randomness of investment returns. Further experimentation with the phased withdrawal rules would yield better performing rules, but the impact of unpredictable investment returns cannot be effectively neutralized with a portfolio split between stocks and bonds.

A more predictable income stream and final balance are possible if retirees are allowed to invest most of their assets in a risk-free asset—that is, an asset for which there is no risk that any payment of interest or repayment of principal will not be honored in full. Even a risk-free asset is not a guarantee of a completely stable income stream, however.¹⁶ That would require the retiree to invest in financial instruments such as Treasury Inflation Protected Securities (TIPS) or other inflation-indexed zero-coupon bonds. Retirees buy a set of indexed bonds, which do not pay interest and mature in successive years. The retirees would have bonds that mature in the first year of retirement, in the second, in the third, and so on to the last year. The retirees can choose to hold bonds with the same real value at maturity, and they then know precisely what constant real income they can expect in each year of their retirement life. However, the steady income stream that the bonds provide normally comes at a cost of a low rate of return. For example, if the rate of return were equal to 1 percent in real terms, the \$500,000 nest egg would sustain an annual income of about \$22,700 over 25 years, exhausting the nest egg by age 90.

We must now take account of uncertain lifetimes. Longevity risk poses an intractable problem for a phased withdrawal strategy, which cannot substitute for annuitization in the provision of longevity insurance. Even if the life expectancy of different cohorts of a population were known with certainty, average life expectancy is not much help as a planning tool, because so much individual variation surrounds the mean.

Notwithstanding the limitations of averages, financial advisors sometimes assume for planning purposes that a client will live as long as the average member of his or her age cohort is expected to live. This assumption guarantees that the client has about an even chance of living past that date. At the other extreme, an advisor might assume that a client will live to be 95 or 100 just to be on the safe side. The chances that the client will surpass so advanced an age are small, but now the nest egg must be made to last even longer, and annual income will be even lower.

Phased withdrawals may well remain the dominant strategy for most retirees in the United States. Even retirees who have been covered for a time by a traditional pension may not have enough service to qualify for a respectably sized annuity.¹⁷ It is not certain

¹⁵ Rule 4 functions like an error correction mechanism. A realistic benchmark for the account balance would have it decline smoothly from \$500,000 at age 65 to close to zero at age 90.

¹⁶ A retiree who invests entirely in risk-free bonds will still encounter investment risk (when bond prices are down and the retiree needs to sell some of the holdings before they mature) and interest rate risk (when a bond matures, interest rates have fallen, and the proceeds of the redemption have to be reinvested in instruments with lower yields). Webb (2009) addresses these issues.

¹⁷ In 2008, only 31.5 percent of the U.S. workforce age 25 years and over had tenure of 10 years or more (Bureau of Labor Statistics (2008)).

whether more sophisticated approaches like those this report explores below will become commercially viable, and many retirees may prefer to have access to more of their capital and to invest some of it in risky assets. If so, they will need to follow a strategy similar to Rule 4, and withdrawals will have to be quite elastic with respect to the deviation of the actual path of account balances from some norm. This will require vigilance, self-control, and some financial expertise.

Short of investing in low-yielding risk-free assets, and quite apart from the risks posed by an uncertain lifetime, retirees will not be able to stabilize both withdrawals and the bequests they will leave their heirs. By making appropriate adjustments when asset returns are abnormally high or low, however, they should be able to damp down the fluctuations in the stream of withdrawals and the final balance.

ADD-ONS TO DEFINED CONTRIBUTION PLANS THAT OFFER LONGEVITY INSURANCE

Two financial products recently introduced in the United States may enhance the ability of DC plans to address the risk of a retiree's outliving his or her resources. The first grafts onto a 401(k) plan a variable annuity—an annuity with a return that varies with the return on the assets that back it—with a guaranteed minimum withdrawal benefit. The insurance companies that provide this instrument guarantee a minimum withdrawal expressed as a specified percentage of plan assets measured at one or more dates (such as the highest balance achieved to date). Provided the insurance company can make good on its promise, the plan member is guaranteed some income for life.

The variable annuity with a guaranteed minimum withdrawal benefit that is embedded in the instrument is a risk-sharing arrangement intended to provide retirees with a rate of return that is higher on average than the rate they would obtain from investing in safe low-yielding assets. It is not a life annuity, and there is no pooling of longevity risk, because the account balance may be bequeathed upon the holder's death. The guarantee of lifetime income is financed by a fee that is additional to the fee for investment management. Because the guarantee is expressed in nominal terms, the level of guaranteed income in real terms tends to decline over time in a persistently down market when inflation is persistent.

The second product is the in-service annuity. This type of instrument, which is still uncommon, effectively exchanges a contribution to the plan as it is made for a stream of lifetime income that begins at retirement, much as a traditional DB plan does. Rather than the purchase of one annuity at retirement or several in the approach to retirement, the in-service annuity entails the purchase of a single small nominal annuity with each contribution (or perhaps with a batch of contributions).

401(K) PLANS WITH GUARANTEE

The 401(k) plan with the income guarantee has been designed to attract assets in 401(k) plans as their holders approach retirement, but it is also intended to attract individual retirement account (IRA) holders nearing retirement (or actually retired) who are looking for some degree of income security in retirement, and DC plan members more generally. It has an accumulation as well as a distribution phase, but because the insurance

companies are targeting workers who are contemplating retirement (for example, by imposing a minimum age on participants, such as 50 years, as a condition of eligibility), the former phase is likely to be shorter than the latter. We refer to it as a DC plan with a guarantee feature, or DC_G plan. The mechanics of a prototypical DC_G plan are as follows.¹⁸ Participants are offered a choice of investment funds, with asset allocations that might range from somewhat conservative—more bonds than stocks—to aggressive—most of the portfolio is invested in growth stocks. Participants continue to maintain an account with investments in these funds when they elect to begin drawing their guaranteed income, and they may change their portfolio's asset allocation during the decumulation phase.

The amount of income that is guaranteed depends on the performance of the account holder's investments and the formulation of the guarantee. Specifically, guaranteed income is determined by applying a fixed percentage, such as 5 percent, to the highest nominal value attained in the postretirement period. The way guaranteed income is determined means that its real value may either rise or fall over time; it is not indexed for inflation. Participants can always supplement their guaranteed income by making an additional withdrawal. Doing so reduces the account value from which the guaranteed income is derived, however.¹⁹

We analyze the performance of the DC_G plan under two different withdrawal rules or strategies, and we examine its success in maintaining a stable income stream with the Monte Carlo simulation technique already used. Because the DC_G's guarantee is expressed in nominal, not real terms, these simulations are conducted with nominal, not real values, and a constant rate of inflation equal to the average rate over 1929–2007 is assumed (see box 3). However, the money values presented in the simulation results are expressed in real (2009 dollar) terms.

Under the first DC_G strategy, withdrawals never exceed the guaranteed income. Under the second, withdrawals are allowed to exceed the guaranteed income when necessary to maintain the initial purchasing power of the withdrawal. That is, under the first strategy, withdrawals are set to a fixed nominal amount (in this case, \$25,000) and not increased unless the value of the portfolio increases. Under the second, they are set to an amount fixed in real terms (worth \$25,000 in 2009 dollars). The assumptions underlying the simulations, apart from the choice of nominal rather than real rates of return, are the same as those underlying the simulations of the phased withdrawal strategies (see box 4).

In particular, participants expect confidently to live until but not beyond the age of 90. As before, this assumption allows us to focus on investment risk. As in the test of the do-it-yourself approach, the fees that participants pay for the management of their portfolios amount to 1 percent of its outstanding value. The DC_G plan also charges an additional 1 percent for the guarantee it provides.

¹⁸ The broad features of the plan the text describes are similar to those of investment vehicles with a guarantee feature that are offered by at least one insurance company, but not an exact replica.

¹⁹ As an example, suppose the guaranteed income base is \$480,000. With a guaranteed withdrawal rate of 5 percent, guaranteed income is 5 percent of the base, or \$24,000. An additional withdrawal of \$40,000 would reduce the guaranteed income base by that amount and the guaranteed withdrawal by \$2,000.

Box 4. Assumptions Used in Monte Carlo Simulations of the DC_G Plan

Financial parameters*

Rates of return (in percent)

Large cap	12.3
Long-term bonds	6.2

Standard deviation (in percent)

Large cap	20.0
Long-term bonds	8.4
Initial balance	\$500,000
Equity-bond mix	50-50
Initial withdrawal rate	5 percent of capital
Marginal and average tax rate	15 percent
Fees (covering all services except the guarantee)	1 percent of capital
Charge for guarantee fund	1 percent of capital
Annual rate of inflation	3.1 percent

*The distribution of returns is assumed to be lognormal (i.e., with the return—the increase in the value of the asset—denoted by r , $\log(1+r)$ is a normally distributed random variable). The rates of return and standard deviations are based on the performance of U.S. stocks and long-term and short-term government bonds over 1929–2007.

Source: Morningstar 2008.

When withdrawals are set exactly equal to the nominal guaranteed amount, the real income that the DC_G plan generates can change from one period to the next with the price level. Moreover, because the guarantee is set in nominal terms, the guaranteed withdrawal in real terms will decline over time unless the nominal value of the portfolio is rising at least as fast as the inflation rate. The guarantee does place a nominal floor on how low withdrawals can go, although average income in the last five years drops to \$16,200 in 2009 dollars (see table 3). Under the nominal DC_G, the actual account balance can be reduced to zero and withdrawals will still be positive.

Consequently, the DC_G gives the account holder some, albeit quite unpredictable, protection against privation in old age. The price for that insurance is a lower average withdrawal (see table 3), about \$4,100 less than

	First Strategy	Second Strategy
Average Withdrawal		
Mean	20.1	23.4
Standard deviation	3.0	2.1
Average Final Five Years' Withdrawal		
Mean	16.2	18.1
Standard deviation	4.5	8.5
Final Balance		
Mean	386.2	152.8
Standard deviation	302.5	355.9
Probability of exhaustion (in percent)	0	0

Source: Author's simulation model. For assumptions, see text.

under phased withdrawals Rule 1, and \$9,400 less than under phased withdrawals Rule 4, which also provides some protection from complete penury.

Next, we allow withdrawals to exceed the guaranteed amount when necessary to maintain the real purchasing power of the first withdrawal. The risk with such a strategy is that when withdrawals habitually exceed the guaranteed amount, the resulting reductions to the guaranteed amount will lower it to the point at which it provides little protection against longevity. The strategy does impart some stability to income withdrawals. About 50 percent of the time, withdrawals can be maintained at the initial real level throughout retirement. But withdrawals above the initial guarantee reduce the account balance and erode the nominal guarantee. As a result, the withdrawals have about a 30 percent chance of falling below \$17,000 in 2009 dollars in the last five years of retirement.

Whether withdrawals are fixed in nominal terms by the level of the initial withdrawal or allowed to vary to maintain their real value, the DC_G does not perform better overall than a sophisticated phased withdrawal strategy, such as Rule 4. It does have two advantages, however, over the phased withdrawal strategy. First, when withdrawals are fixed at the *nominally* guaranteed amount, the DC_G will keep paying that nominal amount as long as the account holder is alive. Second, it is possible to predict the minimum nominal value of the guaranteed income that the DC_G will pay. Given the parameters of the model presented here, that amount would be \$25,000 (5 percent of \$500,000).

IN-SERVICE ANNUITIES

The in-service annuity (ISA) is the most novel of the alternatives to a traditional pension plan, and at the same time, its resemblance to the traditional plan is greater than the other alternatives. The ISA is novel in three ways. First, it reduces or eliminates investment risk by minimizing—effectively eliminating—the time that elapses between a contribution and its conversion into a stream of deferred fixed income. When distributions from a retirement savings account take the form of an annuity, the conventional approach is to convert the accumulated balance of a retirement savings plan into a single annuity in the last year or perhaps several annuities in the last few years before retirement. That approach keeps retirees exposed to investment risk throughout their careers. With the ISA, the conversion takes place more or less continuously during the latter half of a plan member's working life.

Second, the ISA reduces interest (and income) risk by annuitizing savings in many installments rather than in just a few. In this respect, the ISA works similarly to the dollar cost averaging technique applied to stock purchases. Converting savings gradually over time into a stream of future income rather than doing it all in a single or small number of installments before retirement lowers the risk of the investor being obliged to annuitize at a high premium because interest rates happen to be low during the investor's last few years of work. A further possible advantage is that gradual annuitization is less daunting than a one-time annuitization.

Finally, early annuitization of savings means that, provided the plan members do not require a guarantee of principal or continued income upon their death, the deferred income stream purchased by a given amount of savings before the start of the annuity payments is greater than it would have been had the savings been invested in conventional instruments until the members retired and annuity payments began (see box 5 for further discussion).

The premium per dollar of income in a given year will also depend on the intermediation costs of deferred annuities, which are likely to exceed the costs of immediate annuities. A long-standing problem with the pricing of deferred annuities has been the difficulty of matching the duration of the annuity income flows with those of a long-term bond. For example, if an insurance company offers a deferred annuity to a cohort of 50-year-old women, with payments beginning at age 66, the company is making a commitment to provide income at least 50 years in the future, because some of the cohort's members will live to age 100 or more. Matching this distant liability with income from a long-term bond is not possible if the longest bond maturity is 30 years. Even the principal repayment of a Treasury bond has a maximum duration of 30 years, leaving it substantially short of the number of years of postretirement life that many Americans can expect.

In practice, the survival rates at advanced ages of the cohort's members may be sufficiently low that little risk is entailed by backing the long maturity claims with shorter maturity assets. In the United Kingdom, the mismatch problem is mitigated by the development of a swap market, in which a floating income stream may be swapped for a 50-year fixed income stream.²⁰ It is uncertain, however, whether the counterparties to such transactions can really guarantee the payment of a fixed income for so long a term. The need for insurance companies to take account of the risk of a maturity mismatch (or the extra cost entailed by hedging in the derivative market) would increase the premiums paid by a plan participant for a given level of interest rates, but by an amount that is difficult to gauge.

Because it is hard to devise a meaningful measure of the average premium paid over a long period, the modeling exercise that follows concentrates on the impact of interest rate variability on replacement rate variability. By making assumptions about the contribution

Box 5. The Pricing of Deferred Annuities

Suppose that savings of amount S_{64} at age 64 can purchase an annuity with a lifetime income stream of A dollars per year that begins at age 65. With a constant interest rate of r and costless financial intermediation, it should be possible to purchase the same income stream at age 55 for the sum $(S_{64}/(1+r)^9)$ with a guarantee of return of the purchase price plus interest. But if there is no guarantee should the annuitant die before age 65, then the cost to the provider of a deferred annuity at age 55 (C_{DA55}), where SP_{55-64} stands for the probability that the annuitant survives from age 55 to age 64, is given below:

$$C_{DA55} = (S_{64}/(1+r)^9) \cdot SP_{55-64}.$$

If the insurance company providing the arrangement offers a guarantee of principal or some similar guarantee in the event of a plan member's death before retirement, then the cost of a deferred annuity will be higher than C_{DA55} . If the guarantee is for the nominal value of the contribution, the insurance company should be able to offer a price that is less than $(S_{64}/(1+r)^9)$.

Source: Author's formulation

²⁰ In other words, the insurance company selling annuities invests its premium income in an instrument with a rate tied to an interbank lending rate or some other short-term rate. It then swaps the income for a fixed stream of 50 years maturity.

rate and the growth rate of salaries, it is possible to derive estimates of the replacement rate that an ISA would provide and to simulate its variability. The exercise assumes costless financial intermediation and no taxes, and so takes no account of the potential impact of these extra costs on premiums.

Whether an ISA could be a good alternative to the traditional career-end annuity depends on both the average replacement rate it would generate and the variability of that rate. The model presented here assumes for simplicity that the plan member buys a deferred annuity once a year, with payments from all the annuities thus purchased to begin at age 65.²¹ All of the premiums are assumed to be invested in bonds, which have the same duration as the annuity payments they will finance. Hence, the premium per dollar of annuity income contracted in a given year depends on how far in advance of retirement the annuity is purchased, the rate of interest prevailing the year the annuity is purchased, and the plan member's life expectancy.²² It is assumed that the plan member begins contributing at age 45. Consequently, the first annuity purchased is deferred for 20 years, the second for 19, and so on. As in the analysis of the DC_G plan, we assume that the interest rate is a stochastic variable, and we use Monte Carlo simulation to determine the variability of the replacement rate. The appendix details the model used in the simulations and the way replacement rates were calculated.²³

By simulating the model, we find that the replacement rate has a relatively compact distribution. In addition, it is not particularly sensitive to the assumed rate of salary growth (see table 4).

Table 4											
Frequency Distribution of Replacement Rate											
<i>(ratio of annuity payment to average contributory income)</i>											
Salary Growth (in percent)	Percentile										
	0	10	20	30	40	50	60	70	80	90	100
3.5	0.42	0.49	0.51	0.51	0.52	0.53	0.54	0.55	0.56	0.58	0.69
4.0	0.41	0.48	0.50	0.51	0.52	0.53	0.53	0.54	0.56	0.57	0.68
4.5	0.41	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.66

Source: Author's calculations. For assumptions, see text.

ISAs COMPARED WITH DC_G PLANS

The fact that withdrawals from a DC_G can vary a great deal may obscure some points of similarity with the ISA. A participant in a DC_G who sticks to the guaranteed minimum withdrawal is effectively receiving an annuity fixed in nominal terms, although the income it will generate can be increased if buoyant financial markets increase the value of the portfolio.

²¹ This assumption is tantamount to assuming that the premium is set or reset once a year. In practice, premiums might be set more frequently.

²² Insurance companies (to date the only annuity providers in the United States) can finance annuities with a combination of assets. A pricing formula can be more easily derived, however, if it is assumed that funding is 100 percent bonds.

²³ Inflation-indexed annuities are not common in the United States, and the annuity we model in this report is in nominal terms.

In the case of an ISA, the income will be fixed from the start of the decumulation phase; it will vary with fluctuations in interest rates over the course of the accumulation period. Because both incomes are in nominal terms, they will decline gradually in real terms over time as long as inflation is positive. Given the assumption of costless financial intermediation, the fact that the ISA's income is deferred, if no guarantee applies, means that the expected income from an ISA should substantially exceed that of the DC_G.

A more precise comparison of the ISA with the DC_G or a phased withdrawal strategy, like the comparison the report has made among phased withdrawal strategies, is not entirely straightforward for two reasons. The first is that with a phased withdrawal or a DC_G, the participant has already accumulated \$500,000 in his or her account. With the ISA, the participant accumulates a sum over 20 years. To make a comparison possible, we assume that the contributions to the ISA have a value in the base year (2009) of \$500,000. We do this by assuming a constant contribution rate and calculating a starting salary and rate of salary growth (for realism) that will result in the correct figure for total accumulation.²⁴

The second reason is that the premium per dollar of an ISA will be affected to an unknown extent by the costs of financial intermediation. These costs are known in the case of the other two instruments. In the case of the ISA, the basis for estimating them is not solid. Without a clear alternative, the assumption of costless intermediation is maintained. However, the resulting estimates of income the ISA will pay will be biased upward.

The average simulated income an ISA generates is in fact far higher than that of the other approaches (see table 5). In addition to the assumption of costless financial intermediation, this reflects the fact that the annuities the ISA provides are deferred, and the lack of a guarantee on principal invested. In light of our ignorance about the ISA market, these estimates should be taken with a grain of salt.

Table 5				
Comparative Performance of a Sophisticated Phased Withdrawal Strategy (Rule 4) with the DCG and the ISA				
<i>(in thousands of dollars except where noted)</i>				
	Phased Withdrawals Rule 4	DC_G		ISA
		First Strategy	Second Strategy	
Average Withdrawal				
Mean	29.5	20.1	23.4	48.4
Standard deviation	6.6	3.0	2.1	3.2
Average Final Five Years' Withdrawal				
Mean	26.7	16.2	18.1	34.8
Standard deviation	6.1	4.5	8.5	2.3
Final Balance				
Mean	64.1	386.2	152.8	n.a.
Standard deviation	10.2	302.5	355.9	n.a.
Probability of exhaustion (in percent)	0.0	0.0	0.0	0.0
<i>Note:</i> n.a. = not applicable.				
<i>Source:</i> Author's simulation model. For assumptions, see text.				

²⁴ Contributions are accumulated forward from the first one made to the last at a constant rate of interest.

QUALIFICATIONS TO THE ISA APPROACH

Any judgment at this stage about the suitability or appropriateness of an ISA needs to be tentative, given the lack of experience with these products. The discussion has noted two features of the product about which more needs to be known: (1) the ability of insurance companies to hedge against longevity risk, and (2) the cost of financial intermediation.

The ISA, if it can be efficiently supplied, should provide retirees with a steady and relatively predictable source of income. Whether it is appropriate to any particular retiree depends on the retiree's situation—notably, the extent to which the retiree's wealth is annuitized—and taste for risk. The conditional rate of return on an annuity—that is, the rate of return earned by an annuitant who lives to the maximum age—is determined by the yield on the bonds that back it and by the annuitant population's life expectancy. With an efficient market for annuities, the conditional yield should exceed the yield on bonds by a noticeable margin, which increases as the annuitant's age upon contracting the annuity increases. However, the conditional rate of return may well fall short of the expected rate of return of a portfolio that includes stocks and other risky assets as well as bonds.

Some retirees, particularly those who are good at managing their money and establishing and sticking to withdrawal schedules, might prefer to leave their assets in a fund with a guaranteed minimum rate of return. Similarly, retirees with a high share of their wealth already in annuitized form, such as those with both Social Security and an employer-provided pension that combined produce a high replacement ratio, would probably steer clear of any other annuity.

There is a certain similarity between the ISA and the advanced life delayed annuity (ALDA).²⁵ Both involve gradual annuitization (multiple payments by the annuitant) during working life and a substantially deferred start to payments to the annuitant. With the ALDA, the annuity payments are fixed at the outset and do not begin until an advanced age, such as 80. The cost of the annuity is reduced substantially by being so long deferred, which increases the share of saving that can go to equities and other risky assets. Because payments begin at so late an age, the annuity's conditional rate of return is very high.

SUMMARY AND IMPLICATIONS FOR POLICY

The declining coverage of the traditional pension has undoubtedly reduced retirement security in the United States. Provided participants in these plans had long tenures, they would be well protected against all three of the principal risks of retirement finance.

This report has judged whether other kinds of pensions could be an adequate substitute for the traditional pension. It gauges the ability of hybrid pensions and two financial instruments developed for 401(k) participants nearing retirement to deal with retirement risks, especially the risk of nest egg exhaustion.

Hybrid plans are superior to 401(k)-type plans in certain respects. In particular, if workers tend to make shortsighted saving decisions, the contribution rate (including employer

²⁵ See Milevsky (2006, chapter 10) for a discussion of the ALDA.

matches) of these plans is likely to be less than that of hybrid plans. Similarly, hybrid plan participants are subject to little, if any, investment risk. Participants in 401(k) plans, who typically hold a large share of their balance in equities, are subject to more risk.

The main shortcoming of hybrid plans as they operate in the United States is that they, like the vast majority of 401(k)-type plans, provide no longevity insurance. This is not an inherent feature of these plans. Hybrid plans in both Switzerland and Denmark encourage or require annuitization of plan balances (Mackenzie, forthcoming). It might be possible to develop and implement a policy of automatic annuitization to encourage the annuitization of at least part of the balances of hybrid and 401(k) plans. A default setting entailing the annuitization of some specified percentage of an account balance would be established, subject to certain conditions, to discourage excessive annuitization of retirement assets and excessive premiums. Such a policy would face some hurdles, notably overcoming problems of fiduciary liability. Nonetheless, the potential benefits make it well worth pursuing.

The two 401(k) add-ons examined would provide some degree of longevity insurance. The DC_G guarantees a minimum income in nominal terms of (in the report's example) a fixed percentage of the opening balance. An account holder could withdraw this amount indefinitely, regardless of the performance of financial markets. The minimum income would increase when the value of the portfolio increased, and would remain above its former level even if the value of the portfolio subsequently declined. Withdrawals exceeding the minimum guaranteed amount would reduce future guaranteed withdrawals, however.

The ISA would provide participants with a deferred annuity. The premium per dollar of income would vary, given mortality rates, with interest rates. Because annuitization would be gradual, the variation in the premium per dollar would be much less than the variation in the premium of a single purchase. Similarly, the deferral feature, particularly if it were offered without a guaranteed return, would substantially reduce the premium per dollar. The conditional rate of return of the annuity likely would be substantially higher than the minimum return on the DC_G, although the difference between them would depend on the cost of intermediation. The difficulties of estimating the cost of providing an ISA make it hard to be definitive.

Given the importance of adequate longevity insurance, public policy should aim to reduce unnecessary obstacles to the annuitization of 401(k) plan balances and should adopt measures to reduce the cost of supplying annuities. In addition to the policy of automatic annuitization, these measures could include an increase in the maximum maturity of government debt and the issue of government longevity bonds. This latter measure would reduce the risk entailed by underestimating the longevity of particular age cohorts, because the bond's payments increase with the average longevity of a particular cohort, giving annuity providers a hedge against aggregate longevity risk. The development of a market for ISAs and annuities more generally would tend to reduce premiums, creating a virtuous cycle.²⁶ Finally, given the widespread misunderstanding of annuities, efforts to improve financial education should address the decumulation phase of the retirement finance cycle, not just the accumulation phase.

²⁶ The life expectancy of annuitants exceeds that of the general population. An expansion of the general population would reduce annuitant life spans, tending to lower premiums.

APPENDIX. DERIVATION OF FORMULAS FOR HYBRID PLAN BALANCES AND SIMULATING DEFERRED ANNUITY PRICES

FORMULAS FOR THE CASH BALANCE PLAN

The formula for the amount accumulated (AA_t) by the year of retirement (R) that is attributable to participation in the plan in a particular year t is given below, with PAY_t standing for the salary paid in the year t , p_t for the pay credit percentage, and i_t for the interest rate, which is assumed to be applied to the balance of year $t-1$:

$$AA_t = p_t \cdot PAY_t \cdot \prod_{S=t+1}^R (1+i_S) \quad (1)$$

The total accumulation over the worker's career (CA) is given by the following formula, where H stands for the year of hire:

$$CA = \sum_{t=H}^{R-1} \left(p_t \cdot PAY_t \cdot \prod_{S=t+1}^R (1+i_S) \right) \quad (2)$$

The formula for the cumulative balance in equation (2) is exactly the same as the formula that would apply in the case of a defined contribution (DC) plan with a contribution rate of p_t and a rate of return to contributions of i_t .

Transforming the formula for the accumulated balance into a formula for an annuity illustrates the kinship between cash balance (CB) plans and traditional DB plans. Dividing both sides of equation (2) by an annuity factor \ddot{a} , letting P_{CB} stand for the value of the annual pension and assuming that the pay credit percentage is fixed, yields equation (3):²⁷

$$P_{CB} = \sum_{t=H}^{R-1} \left(\frac{p}{\ddot{a}} \cdot PAY_t \cdot \prod_{S=t+1}^R (1+i_t) \right) \quad (3)$$

As McGill et al. (2005) point out, the resulting formula is that of an indexed career average plan, with the index being the accumulated rate of interest on past pay credits. The contributions made during all years of service receive a weight in the calculation of the benefit, but the weights are not equal as they would be with a career average plan.²⁸

²⁷ An annuity factor is the premium per dollar of annuity income. If the annuity factor has a value of 12, then a premium of \$12,000 buys an annual income of \$1,000.

²⁸ If the rate of interest equals the rate of growth of a participant's salary, the plan becomes the equivalent of a career average salary plan.

FORMULAS FOR THE PENSION EQUITY PLAN

If the accrual factor is d , the number of years worked is $(R-H)$, and the final salary is PAY , then the accumulated balance (AC) at career's end will be as follows:

$$AC = d \cdot (R - H) \cdot PAY \quad (4)$$

Because it places no weight on the early and middle segments of a participant's working life, the difference in the pension earned by high flyers and that earned by low flyers is greater for the pension equity plan (PEP) than it is for the CB plan. In this respect, it is like the traditional final salary plan.²⁹

It is straightforward to transform the expression for the accumulated balance into an expression for the pension annuity (P_{PEP}) as we did for the CB plan:

$$P_{PEP} = \frac{d}{\ddot{a}} \cdot (R - H) \cdot PAY \quad (5)$$

If the plan predetermined the annuity factor, and if the benefit took the form of an annuity, a PEP would be indistinguishable from a final salary plan. It is not, however, so plan participants shoulder longevity risk with the PEP as they do with the CB plan.

SIMULATING THE VARIABILITY OF ISA PREMIUMS

Deriving a simple (unweighted) measure of the premium

Equation (6) is an expression for the premium per dollar for a deferred life annuity contracted when the annuitant is age 45 (PPD_{45}), assuming that annuity payments begin at age 66. Equation (6) shows that the value of PPD_{45} depends on the probability of surviving from age 65 to each subsequent age Z ($SP_{65 \text{ to } Z}$), assuming for convenience that the plan member does not live beyond age 90; on the probability of surviving from age 45 to age 65 ($SP_{45 \text{ to } 65}$); and on the interest rate r , which is assumed to be constant.

$$PPD_{45} = \left(\frac{SP_{45 \text{ to } 65}}{(1+r)^{65-45}} \right) \left(\sum_{Z=66}^{90} \frac{SP_{65 \text{ to } Z}}{(1+r)^{Z-65}} \right) \quad (6)$$

In equation (7), equation (6) is re-expressed to collapse the right-hand side (RHS) to one term:

²⁹ More formally, if we compare a PEP and a CB plan and assuming that the participant earns the same salary every year, and setting the parameters so that the two plans produce the same benefit, any shift in income from early years to the final years of the participant's career will increase the benefit from the PEP above that of the CB plan. The shift lowers the benefit of the CB plan, because income is shifted from years when it has a heavy weight to years when its weight is lighter. An increase in final salary, other things equal, must have a much larger effect on the benefit of a PEP than it does on a CB plan, because the salary paid in earlier years has no weight at all.

$$PPD_{45} = \left(\sum_{Z=66}^{90} \frac{SP_{45 \text{ to } Z}}{(1+r)^{Z-45}} \right) \quad (7)$$

The formulation of equation (6) is convenient, however, because when the premium per dollar is calculated for subsequent years, only the first term on the RHS of equation (6) changes. The right-hand term is the cost of a life annuity of one dollar per year issued at age 65 (i.e., an immediate and not a deferred annuity). For age 46, for example, the first term becomes $\left(\frac{SP_{46 \text{ to } 65}}{(1+r)^{65-46}} \right)$ or $\left(\frac{SP_{46 \text{ to } 65}}{(1+r)^{19}} \right)$. At age 47, the first term becomes $\left(\frac{SP_{47 \text{ to } 65}}{(1+r)^{18}} \right)$.

By adding up the premiums per dollar calculated at each age from 45 to 65 and dividing the sum by the number of years of contribution (21 in this case), an expression for an average premium per dollar is derived.

The simulations use a single interest rate, the Treasury 10-year rate.³⁰ Strictly speaking, the calculation of the premium per dollar should not be based on such a single long-term interest rate, but on the term structure of interest rates. If equation (7) were changed to use the term structure, it would look like equation (8), where r_{Z-45} is the interest rate on a bond of maturity $Z-45$.

$$PPD_{45} = \left(\sum_{Z=66}^{95} \frac{SP_{45 \text{ to } Z}}{(1+r_{Z-45})^{Z-45}} \right) \quad (8)$$

The simplified approach this report adopts is similar to that of Blake (2006, 108–109) and is justifiable on two grounds: it is less demanding computationally, and it is unlikely to result in an understatement of the variability of premiums, because short-term rates tend to fluctuate more than long-term rates, and medium- and long-term rates tend to vary in a similar way. Finally, the simulation uses survival probabilities taken from a study by the Social Security Administration (SSA 2002).

CALCULATING THE REPLACEMENT RATIO

The calculations assume that salary grows at a constant rate g . The premium per dollar increases from one year to the next for a given rate of interest. As before, the estimates assume that plan members buy a deferred annuity each year they participate in the plan.

The replacement rate is the ratio of pension or annuity income to a measure of working life income. The report uses a measure of average income during the period of contributions—a kind of career average, except that the period covered does not include years worked before becoming a member of the plan.

³⁰ The long-term bond yield is assumed to be normally distributed. Its average and standard deviation are based on annual data for 1998–2007 (Morningstar 2008).

Setting first-year income equal to Y_{45} , the contribution rate equal to c , and the growth of salary to g , the numerator of the replacement rate may be expressed as follows:

$$\frac{cY_{45}}{PPD_{45}} + \frac{cY_{45}(1+g)}{PPD_{46}} + \frac{cY_{45}(1+g)^2}{PPD_{47}} + \dots + \frac{cY_{45}(1+g)^{20}}{PPD_{65}} \quad (9)$$

The first term is simply the value of the pension that a plan member buys at age 45. The second is the value of the contributions the plan member buys at age 46, and so on. In like fashion, the denominator is equal to the following:

$$\left(Y_{45}(1 + (1+g) + (1+g)^2 + (1+g)^3 + \dots + (1+g)^{20}) \right) / 21 \quad (10)$$

Dividing numerator and denominator by Y_{45} , and re-expressing the denominator, the resulting expression for the replacement ratio (RR) is as follows:

$$RR = \left(\frac{c}{PPD_{45}} + \frac{c(1+g)}{PPD_{46}} + \frac{c(1+g)^2}{PPD_{47}} + \dots + \frac{c(1+g)^{20}}{PPD_{65}} \right) \bigg/ \frac{(1+g)^{21} - 1}{21 \cdot g} \quad (11)$$

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