The Design and Production of New Retirement Savings Products

by

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ABSTRACT

As pension plans in the U.S. and other countries shift from defined benefit to defined contribution plans, employees are being asked to bear investment risk formerly borne by employers and/or governments. Using a simulation model, this paper examines the performance of alternative investment strategies and products over the working life of a hypothetical employee. The results illustrate the uncertainty inherent in standard investment products and suggest the need for new products that would help employees manage investment risk. The paper explores the performance of investment products that provide a floor on the value of the worker's investment over some period of time, say five years, and also provide some share of the upside of the equity market. These products appear to work well; for example, workers who invest their annual retirement contributions in a series of five-year insured products appear to have a higher chance of achieving their retirement income target than if they were to invest the same amount in the S&P 500 index.

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Introduction

The aging of populations worldwide, particularly in industrialized countries, has placed pressure on pension plans that have a defined benefit. It is a special problem with pay-as-you-go plans since pension payments in public sector programs must come out of current government taxes or borrowing, or from current corporate cash flow for employer-sponsored plans. Countries have begun to react to this pressure in a number of ways, including attempts to increase the retirement age, reducing the ratio of retirement income to final salary (the replacement rate), and loosening investment restrictions on pension funds in an attempt to improve investment returns.

There has also been an important trend away from defined benefit to defined contribution plans to reduce the risk borne by plan sponsors. In some countries, such as Chile, Australia and Mexico, the basic retirement system has been or is being replaced with a defined contribution plan. Employers in other countries, notably the U.S. and U.K., are also shifting to defined contribution plans to reduce the risk and regulatory burden they bear with defined benefit plans. 401(k) and similar plans have grown rapidly in the U.S., supplementing or replacing traditional defined benefit plans. The number of defined benefit plans in the U.S. peaked in 1983, and pension payments from these plans have exceeded contributions since 1984. In contrast, the number of defined contribution plans grew 46% between 1983 and 1993, the last year for which data are available, and the number of participants in these plans surpassed that of defined benefit plans in 1992.[1]

This shift to defined contribution plans has some benefits for employees. Employees know the value of the funds in their retirement account and they have the freedom to make investment choices from the array of options available in their company's plan. This investment choice allows the employees to select a risk profile consistent with their own preferences and circumstances. In addition, the retirement assets in a defined contribution plan are portable when an employee changes jobs. While vested assets in a defined benefit plan are also portable, there is a cost to the employee in most of these plans. Employer contributions to defined benefit plans are typically small in the early working life of an employee because the pension benefit that a worker earns depends upon years of employment as well as salary.[2] Thus, an employee who works for five years in each of four jobs will generally have a much smaller pension accumulation than an employee who has stayed with one employer for twenty years.

A key issue in the shift to defined contribution plans, and the one addressed in this paper, is that employees bear all the investment risk inherent in these retirement savings programs. This is a sharp contrast with defined benefit plans in which pension plan sponsors guarantee a retirement income

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[1] Source: Private Pension Plan Bulletin, U.S. Department of Labor, Number 6, Winter 1997.

[2] To attract employees, some U.S. employers have begun to offer a new form of defined benefit plan, called a Pension Equity Product (PEP), in which the plan contributions are more heavily weighted toward the early years.

benefit and, in consultation with actuaries and plan consultants, make regular adjustments in pension contributions to achieve the target. In defined contribution plans, investment risk is being passed on to the parties that are least knowledgeable and least able to bear it.[3]

An important question with defined contribution plans is whether individuals, left to their own devices, allocate their retirement funds in some inappropriate manner, for example, holding an extreme cash position. Recent evidence provides some encouragement on this front. For example, Bodie and Crane (1997) reported a study of asset allocation by participants in TIAA-CREF, the large non-profit organization that handles self-directed retirement funds for the staff of some 6,000 universities, secondary schools and other non-profit organizations. The study was based on a unique survey that provided information about the total asset holdings of respondents, including the asset composition both within and outside their retirement accounts. The analysis showed that respondents, on average, managed their assets in accordance with what might be called "generally accepted investment principles." Respondents, on average, held emergency funds in short-term, safe assets outside their retirement accounts. Retirement accounts were invested predominantly in equities and longer-term fixed income securities. Finally, the fraction of longer-term assets held as equity declined with age and increased with wealth in line with the conventional wisdom on this subject.

[3] For a complete comparison of defined benefit and defined contribution plans, see Bodie, Marcus and Merton (1988).

While such studies do provide some encouragement, it is important to note that even when employees adopt the standard advice during their working years, they are still exposed to considerable investment risk if their objective is to achieve a target income during retirement years. Investment in equities provides a relatively high expected return, but as Bodie (1995) has pointed out, equities are still risky over the long-term. Our simulation results reported below confirm that there is a significant chance missing a retirement income target when a worker invests his or her annual retirement fund contributions in equities or a mix of equities and fixed income securities. Furthermore, the standard tools available to help investors make asset allocation decisions, such as finanical planning software, are not very helpful. Sharpe (1997) has pointed out a number of concerns with the standard packages.

Retirement Income Contracts

We believe there is an opportunity for new products to help employees manage their retirement income risk. One idea is a new product, called a Retirement Income Contract, that could be made available by a financial intermediary for employees in a 401(k) or other defined contribution plans. An employee could use his or her annual retirement contribution to purchase one of these contracts which would provide a guaranteed monthly income stream at retirement. Such contracts could, in theory, be designed so that purchasing a stream of these contracts over a working life would result in a program that contained the best features of both defined contribution and defined benefit plans.

A simple version of a retirement income contract has existed in the past. Prudential, John Hancock and other insurance companies offered individual deferred life annuities for employer pension plans. These contracts, purchased each year with retirement fund contributions, provided a specified monthly income at the employee's retirement age. This early version of a retirement income contract was phased out as the result of a suit brought by Harris Trust against John Hancock Insurance Company. In 1992, the plaintiff successfully argued in appeals court that John Hancock had a fiduciary responsibility for this product under the Employees' Retirement Income Security Act (ERISA). This meant that funds received from the sale of these annuities had to be managed "solely for the interests of the employee" and thus could not be managed as part of the insurance company's general investment account.[4] The product was much less attractive to insurance companies if the funds had to be managed in segregated accounts.

Apart from regulatory issues, the challenge posed by retirement income contracts is the long time horizon involved in the guarantee and the lack of appropriate hedging instruments. However, it is clearly possible to guarantee returns over shorter time periods and some interesting products have emerged in recent years. The particular kind of product explored in this paper is one that combines downside protection over a specified period of time with some

[4] *Business Insurance*, August 10, 1992.

upside tied to the performance of stock market indices. Merton, Scholes and Gladstein (1978) first explored this idea, simulating the performance of a portfolio in which 90% of the funds were invested in 6-month commercial paper and the remainder was used to purchase a portfolio of 6-month call options on selected individual stocks. This idea was actually put to work with the formation of a new mutual fund, Money Market/Options, Inc.

Investor interest in this kind of product has grown more recently. In 1995, life insurance companies began to offer in the U.S. five to seven-year variable annuities which combined a floor with some upside. Also, Merrill Lynch has periodically offered a security with this feature. In November 1997, for example, Merrill Lynch offered a five-year “Market Index Target-Term Security” (MITTS) tied to a market index of 11 major non-U.S. stock markets. At maturity the holder of this debt security receives the principal amount invested plus 115% of the increase, if any, in the major market index.

By 1997, some thirty insurance companies had introduced these products in the U.S. These equity-indexed annuities appear to have sold well, but have also received some criticism in the press.[5] Part of the concern is that these annuities are being sold to individuals who may not understand the product features or for whom the product may not be appropriate. Most of these products are not registered with the Securities and Exchange Commission and therefore can be sold by agents who do not have a license to sell securities. The

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[5] Bridget O’Brian and Leslie Scism, “Equity-Indexed Annuities Score Big Hit, But They Put High Price on Protection,” *Wall Street Journal*, May 30, 1997, p. C1 ff.

other issue is that the design features of some of these early products were not very attractive from the viewpoint of consumers.

In spite of concerns with some early versions of these protected annuity products, we believe that improved versions of such products would make a useful contribution to retirement savings programs because of their performance characteristics. To explore this issue, we constructed a simulation model to study the investment performance of a hypothetical worker who made annual contributions to his or her retirement fund. Our results suggest that a series of investments in an insured product have a much higher chance of allowing the worker to reach a specified retirement income target than do investments in a mixture of equity and fixed income securities.

Simulation Model

The hypothetical worker in our simulation model retires at age 65 having earned $50,000 in the final year of employment. The worker's target income at retirement is 60% of final salary or $30,000. Assuming a known life span of 20 years after retirement and a nominal interest rate of 7%, a fund of about $318,000 would be needed to provide this retirement income.[6] We believe, however, that it is important to maintain retirement income in real terms. If the real rate is 3%, this would take a retirement fund of $446,000 at age 65 to provide a 20-year stream of $30,000 on a price-adjusted basis.

[6] Actuarial tables take into account the fact that the life span is uncertain. For simplicity, we have assumed that the life span is a known 20 years.

To explore investment strategies over time, we assume that the employee starts working at age 25 and that wages rise at the rate of inflation. At the end of each year, he or she invests a specified percent of wages received. For our “benchmark investment strategy,” we assume that 100% of the retirement savings each year is invested in the U.S. Treasury Inflation Protected Securities (TIPS). To reach $446,000 at age 65, the employee will need to invest 11.84% of wages each year asuming a constant real rate of 3%.[7]

Taking a 100% investment in TIPS as the benchmark strategy, the question then is how well do alternative strategies work when 11.84% of wages are invested each year and the objective is to accumulate $446,000 at age 65. We studied the performance of an all-equity portfolio with 100% of the savings invested in the S&P 500 index, as well as a balanced portfolio strategy with 60% of the funds invested in the S&P and 40% invested in TIPS. We also explored an age-adjusted balanced portfolio in which the share invested in equity declined with age, consistent with the conventional wisdom on the subject. The share invested in TIPS was equal to the age of the employee and the remainder was invested in the S&P index so that the portfolio returns became less volatile as the employee aged.

To simulate the performance of these strategies, we randomly generated several scenarios of stock prices and inflation rates over the working life of the employee. We then evaluated how well each investment strategy worked for each of the scenarios, using the value of the portfolio at retirement age as the

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[7] In late 1997, TIPS were trading at a real rate of about 3.5%.

key measure of performance. With each investment strategy, new money from the employee was invested at the end of each year and any cash received from the previous year's portfolio was reinvested. The 60/40 portfolio and the age-adjusted portfolio were rebalanced at the same time.

A number of assumptions about stock market returns and inflation rates over time were made to construct our scenarios. The S&P index was assumed to be a random walk with an average return of 10% per year, a standard deviation of 20% and a dividend yield of 3%. Inflation was also assumed to be uncertain with an average rate of 4% and a standard deviation of 0.5%. The simulated inflation reverted to the mean at a rate of 0.2. Finally, a positive correlation of 0.5 between inflation and the S&P was assumed. With these assumptions we randomly generated 100,000 scenarios of stock prices and inflation rates and used them to study the performance of the three investment strategies.

Portfolio Simulation Results

Because of the higher expected return, the 100% equity strategy achieved a much higher average portfolio value at age 65 than the benchmark strategy of investing all the funds in TIPS (Table 1). The average retirement value across the 100,000 runs was $856,000, almost double the $446,000 achieved with the benchmark strategy. However, it was a much riskier strategy. In 34% of the simulation runs, the final portfolio value was below the retirement target of $446, 000.

Table 1
Portfolio Values at Age 65

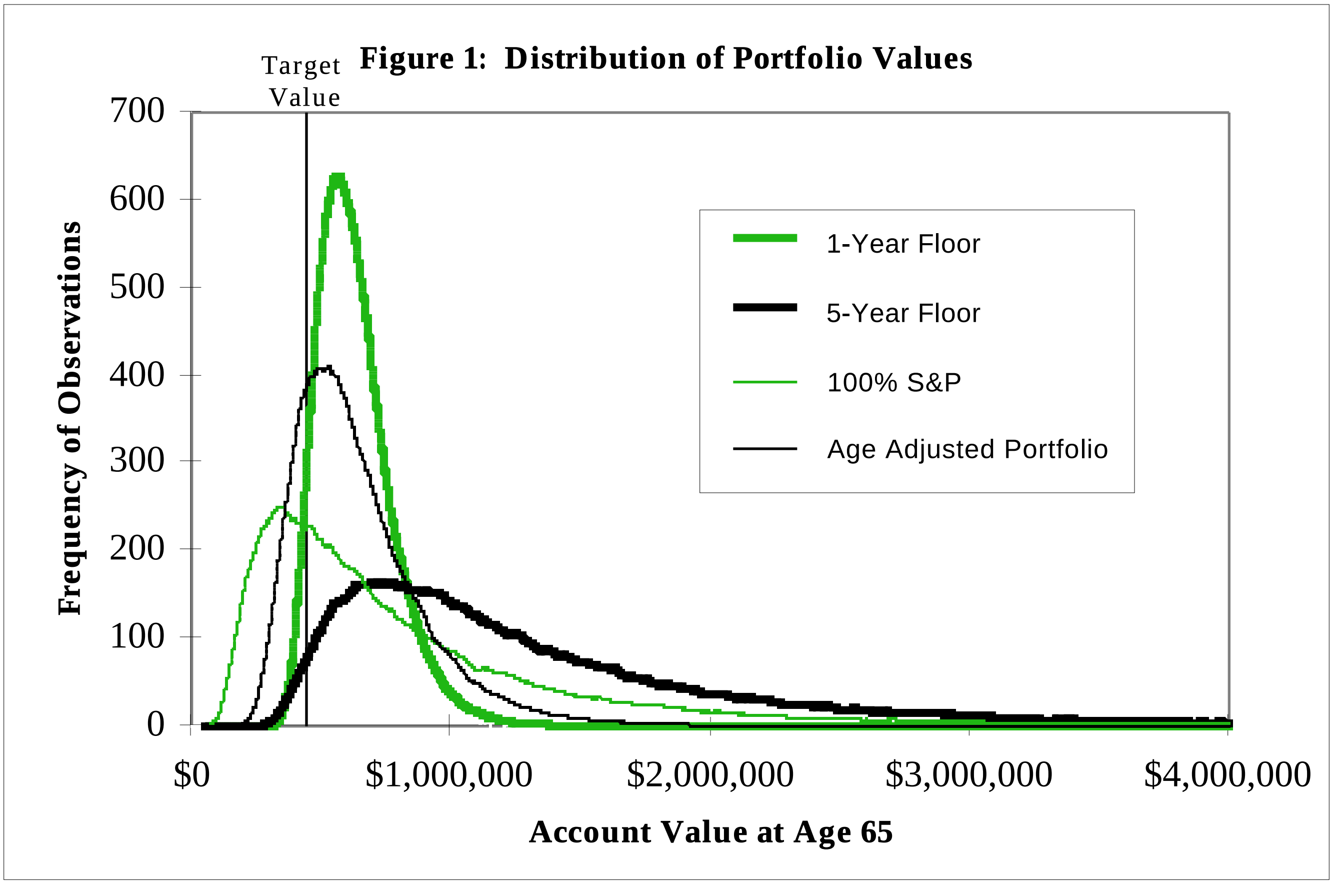
Investment Strategy	Average Value ($000)	% of Results Below Target
100% TIPS	$446	0%
100% S&P	856	34.3%
60% / 40%	654	28.6%
Age-Adjusted	618	26.5%
1 - Yr Floor	581	10.8%
5 - Yr Floor	950	11.6%

The balanced portfolios were less risky than the all-equity portfolio, but a substantial share of the age-65 values were still below the $446,000 target. For the 60/40 portfolios, 29% were below the target. Consistent with the conventional wisdom, the age-adjusted portfolio did slightly better with 27% below target, but this difference may not be significant. As would be expected, the reduction in risk achieved by the balanced portfolios was obtained at the cost of lower average values at retirement age.

Products that combined portfolio protection with some upside potential reduced the risk even further than the balanced portfolios. There are a variety of ways to construct such products, but we explored a straightforward approach that combines the purchase of TIPS with call options on the S&P. This method protects the real value of the principal invested while providing some share of the S&P upside.

We first considered a one-year product which is produced in the following manner. Assuming \$100 is available for investment, \$97.08 is invested in a TIPS. This security earns 3% in real terms, under our assumptions, and thus provides \$100 in real value at the end of one year. The remaining \$2.92 of the original investment is used to purchase a call option on the S&P with an exercise price at the current level. Assuming dividends are not received by the purchaser, this allows the purchase of 38% of the upside of the S&P. Thus, \$100 invested in the retirement fund provides at the end of the year \$100 in real terms and 38% of the increase in the S&P index. This amount is then reinvested, along with new money from the employee, in a new one-year product for the next year.

The investment strategy which uses the one-year protected product greatly improves the odds of reaching the retirement fund target. Only 11% of the resulting portfolios were below target. The cost is that much of the upside is given away so the average portfolio value was only \$581,000. This is above the benchmark of \$446,000 but well below the all-equity or either balanced portfolio strategy. As shown in Figure 1, the distribution of results obtained with the one-year protected product is highly concentrated with about 80% percent of the retirement values between \$440,000 and \$800,000.



The concept of a one-year protected product can easily be extended to a five-year term, much as Merrill Lynch did with its MITTS product. In our approach, $86.26 of a $100 investment was used to purchase a TIPS to protect the real value of the investment for five years. The remainder, $13.74, was then used to purchase a five-year call on the S&P. This gives the employee a much bigger share of the equity upside since it allows the purchase of 90% of the increase in the S&P.

The downside protection with the five-year product is about the same as with the one-year product. The retirement fund was below the target in 11.6%

of the simulation runs, but the average performance substantially exceeded the one-year product because of the greater share of the upside obtained. In fact, the average portfolio value of the five-year insured product at age 65 was better than that of the all-equity portfolio, $950,000 vs. $856,000. Avoiding the downside appears to have substantial benefit. As shown in Table 2, the performance of the five-year product was better than that of the all-equity portfolio in almost 75% of the simulation runs.

Table 2
Distribution of Portfolio Values at Age 65
($000)

Investment Strategy	Percentile 10%	25%	50%	75%	90%
100% S&P	$240	$365	$605	$1,030	$1,709
60% / 40%	328	425	577	794	1,070
Age Adjusted	355	439	563	734	944
TIPS	--	--	446	--	--
1 - Yr Floor	443	500	582	682	797
5 - Yr Floor	432	555	772	1,129	1,650

The results obtained in the simulation runs depend, of course, on the assumptions used in the model. The expected return on the S&P plays an important role in the performance of investment strategies and may be of particular interest. Thus, we ran a set of simulation runs using 12% as the expected return, leaving all of the other assumptions the same. This improves the performance of all strategies that are based in part on equity returns, including the protected products. As shown in Table 3, the mean portfolio value for the all-equity strategy rises to $1,484,000 and only 15% of the results are below the retirement target, substantially better than the 34% obtained when the expected return was 10%. The protected products also do much better. The five-year product, for example, missed the target only 4% of the time and the average portfolio value at age 65 was $1,366,000.

Table 3
Portfolio Values at Age 65
with S&P Return at 12%

Investment Strategy	Average Value ($000)	% of Results Below Target
100% TIPS	$ 446	0%
100% S&P	1,484	15.0%
60% / 40%	900	11.4%
Age-Adjusted	812	9.8%
1 - Yr Floor	690	3.9%
5 - Yr Floor	1,366	3.9%

Conclusion

Protected products do not provide a complete solution to the risk management issues faced by employees saving for retirement. Our results suggest, however, that these new products can play an important role as an investment alternative in defined contribution plans. Futhermore, the technology for producing such products is readily available. Well motivated individuals could even produce a version of the product themselves by purchasing their own TIPS and long-dated S&P index options that are traded on the exchange.

Additional financial innovation would help intermediaries move even further in meeting the retirement income needs of individuals. Employees in defined contribution plans, for example, are still exposed to wage risk even if investment risk is minimized. If wages grow faster than expected, the employee will have to increase annual retirement contributions, or make other adjustments such as postponing retirement, in order to meet a target replacement rate of final salary. Further innovation in the securities market may help provide hedging mechanisms so that intermediaries can continue to move toward a retirement income contract that helps employees reduce this risk, in addition to the reduced investment and inflation risk.

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