The Pension Challenge

Risk Transfers and Retirement Income Security

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Chapter 5

Integrating Payouts: Annuity Design and Public Pension Benefits in Mandatory Defined Contribution Plans

Suzanne Doyle and John Piggott

Defined contribution (DC) style retirement systems have proliferated as partial or complete substitutes for mandatory social security, spawning a growing literature on their possible economic impacts, but associated payout structures have received surprisingly little attention. Nevertheless, DC type retirement provision support and individual retirement accounts pose special challenges for the payout phase. Adverse selection in the voluntary annuities market, prudential considerations, and the implications of interactions between annuity payouts and first pillar type social welfare, all suggest that DC retirement systems require some government regulation regarding the nature of associated retirement benefits.

Unlike traditional DB funds, regulations and employer obligations associated with the accumulation phase typically expire at retirement, even if pension options are offered by the accumulation fund. Any payout regulations must therefore be separately stipulated. In practice, a range of options is specified, ranging from lumpsum withdrawal to full annuitization, sometimes subject to the personal circumstances of the retiree.

This chapter focuses on the design of annuities and similar retirement income instruments. It is especially concerned with interactions between annuity preference and underlying publicly provided safety net support. Because DC-type plans expose individuals to investment and inflation risk, governments often provide guarantees on pension fund benefits, as well as non-means tested transfers to the retired. These influence not only the choice of accumulation portfolio, but also the choice of retirement product, through providing a retirement income floor. They further complicate the analysis of annuity and retirement income markets.

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We focus on the interaction between private sources of retirement income and first pillar government transfers. Two forms of government support are modeled: a "pension guarantee," which is withdrawn dollar for dollar with the private payout, and a non-means-tested public pension offered to all retirees at a flat rate. Results emphasize the welfare impacts of alternatives under a range of income assumptions. A number of themes emerge. First, for most retirees, annuities that expose the retiree to investment risk are preferred to annuities guaranteeing certain payments, when the government shares the investment risk by guaranteeing a minimum pension. Second, on an expected basis, in the lower range of wealth accumulations, which characterize an immature mandatory retirement system, these products may generate a lower expected *government* payout than life annuities offering full investment risk coverage. Third, inflation-protected annuity products are highly valued, especially by the rich and risk-averse, though except for the poor, inflation indexed products yielded lower expected public liabilities. This is because over time, the real value of the level annuity can more quickly erode to the point where a pension guarantee is activated. Finally, some products which offer partial longevity insurance such as phased withdrawals may be preferred by consumers to full longevity insurance products, but the former are often associated with high levels of implied government liability.

We begin by detailing the retirement products we consider and present our modeling approach. We conclude by reporting estimates of consumer preference toward alternative products, along with their budgetary implications.

Characterizing Retirement Income Products

For modeling purposes, we focus on five different retirement income instruments, cover alternative patterns of exposure to longevity, investment, and inflation risks:

1. *Level Life Annuities.* These provide insurance against longevity risk and guarantee a certain payment per period, thus insuring against investment risk. But payments are fixed in nominal terms, so annuitants are fully exposed to inflation risk.
2. *Variable Annuities.* These provide insurance against longevity risk, while at the same time delivering higher expected returns by transferring investment risk to the annuitant. The annuity is written on the basis of an assumed investment return (AIR). Payouts, however, are adjusted by the relationship between the performance of the underlying portfolio, which may be specified by the annuitant, and the AIR. Because investment risk is borne by the annuitant, the AIR may be significantly higher than the risk-free rate.

3. *Inflation-indexed Annuities.* Even a modest inflation rate of 3.5 percent will halve purchasing power in 20 years. Combined with 1-percent wage productivity growth, purchasing power relative to community standards will halve in 16 years. For a retiree with a life expectancy of 15 or more years, as a male retiring at sixty-five would have in most OECD countries, erosion of purchasing power through inflation is thus a significant risk. For longer-lived women, the risk is even greater. While escalated annuities partially address this problem, they do not offer insurance against unanticipated inflation, which may be a larger danger to annuitant welfare.
4. *Term Annuities.* It is possible to purchase an annuity, which provides a guaranteed income stream for a specified period. This kind of product is available for retirement provision in some countries, with a long term. In our calculations, we assume life expectancy as the term set. This product does offer insurance against investment risk, but it offers no longevity insurance.
5. *Phased withdrawals.* The phased withdrawal appears at first sight to be more like a pure investment instrument than a retirement income stream product. Its essence is that a sum of money is invested at retirement, in a portfolio over whose composition the retiree has considerable control. Both income and capital can be drawn down to meet the retiree's needs. The drawdowns, however, are limited to a range, with both upper and lower bounds. These are often set such that the upper bound carries with it an expectation of an even income flow until the life expectancy of the retiree at the point of retirement. The lower bound is set so that withdrawals can be made until the actuarial probability of survival from the date of purchase approximates zero. These "valuation factors" apply to the account accumulation each year.

Retirement Income Payout Streams and First Pillar Benefits

We use a stochastic numerical simulation approach to study consumer preference and government budgetary implications of a number of stylized annuity type payout instruments offered in countries with mandatory DC retirement systems. For convenience, Australian data are used to specify the accumulation, risk-return, and longevity parameters of the model, since this is one of the few developed countries with a fully fledged private DC-type mandatory retirement system. But we consider policy specifications, which are quite general, including some not in operation in Australia.

Calculations of the income flows associated with our menu of annuities are based on variants of standard actuarial formulae. We incorporate stochastic processes for both inflation and real rate of investment returns by assuming that these follow geometric Brownian motion. Assuming that there is no

borrowing or lending, these income flows along with stochastic inflation allow us to calculate real consumption in each period in retirement.

The indices associated with both inflation and investment variables grow at trend rates, which are continuously disturbed by random shocks. This "proportional random walk" implies that the volatility of the time path is proportional to the level of the associated index. We further assume that the inflation and real investment return processes are independent.[1] Each of the reported experiments is based on 5,000 draws from a standard normal distribution.

The simulations reported here assume three retirement accumulations, of $100,000, $200,000, and $300,000, to represent low, medium, and high income levels. A full-time worker on average earnings might be expected to accumulate between $150,000 and $200,000 at retirement age 65.[2] These accumulations differentially impact on first-pillar support. For the payout phase, we have assumed a real safe rate of return of 3.5 percent, an expected inflation rate of 3.5 percent, a risky rate of return of 10 percent, and real wage growth of 1 percent. The current real return on a 20-year indexed government bond is 3.68 percent. While inflation over the last century has averaged 4 percent, existing long-term inflation forecasts are somewhat lower; changed Central Bank policy is sometimes appealed to in defense of these lower figures.

The above values imply an equity premium of 3 percent. This may be low by conventional standards, but in a very thorough study, Siegel (1992) argues that over the last two centuries, the equity premium may have been closer to 3–4 percent than to the 6–7 percent range frequently used. He suggests that the high equity premium observed over the sixty-five years to 1990 was due primarily to depressed rates of return on fixed income assets, and that it is unlikely to endure in the future. Because of the long time horizons involved, we have chosen a conservative equity premium estimate. In the stochastic simulations, the return on equities is assumed to have a standard deviation of 0.2. Inflation is assumed to have a standard deviation of 0.02.

Mortality is specified using Australian population survival probabilities, which are compiled by the Australian Government Actuary (1994) every 5 years. For this analysis we use the 1995–97 life tables, modified to reflect the projected cohort mortality improvements that a 65-year-old purchasing an annuity now might experience over time. Australian mortality is close to the OECD norms.

The first pillar payouts are specified to 25 percent of male average weekly earnings, of about $40,000 a year in Australia (2000). The first pillar is thus indexed to wage growth. The 25 percent calibration is consistent with the levels of pension guarantee offered in Switzerland and Chile, and it is also the approximate value of the full "Age Pension" in Australia. In our central case, the guarantee is withdrawn dollar-for-dollar with annuity payments.

These amounts are indexed to wage growth, assumed here to be 4.5 percent nominal.

Results

One way of assessing efficacy of annuity products involves comparing their payout structures at different points in time. Direct comparison of income streams generated by different annuity products offers only a limited guide to their value to consumers, however. Of greater importance are individual preferences toward alternative income (or consumption) profiles. In assessing the effectiveness of alternative policies, economists often base their recommendations on metrics associated with individual welfare, or utility. This approach is readily adapted to the present problem. We adjust the income flows, which different annuity types yield for assumed inflation. Income-tested public sector first pillar payments are then added in. The resulting real income in each period is assumed to finance consumption in that period alone—there is no borrowing or lending in retirement, and no other source of income. This gives an estimate of consumption for each period, and provides the basis for the utility score calculation.[3]

In what follows, we assume a 65-year-old Australian male retires in 2000, having accumulated a retirement benefit throughout his working life. For simplicity, we focus on three income levels, which we represent by the annuity purchase price, and we use male average cohort life expectancy, an assumption justified by mandatory annuity purchase.[4] Table 5-1 reports product-by-product equivalent variations (EVs) for the five retirement income products identified above, in the policy context of a pension guarantee equal to 25 percent of average earnings, offset dollar-for-dollar with private retirement income. The interpretation of the EVs is that they give an estimate of how much an individual would have to pay as a lump sum, at the point of retirement, to make him indifferent between a level life annuity and the alternative. In each case, we assume that only one alternative is available, and that purchase is mandatory, avoiding issues of potential adverse or differential selection across products.

It is convenient to begin by pointing out the salient characteristics of the income streams generated by the menu of products considered here. Longevity insurance offered by the level life annuity, the variable annuity, and the CPI indexed annuity, means that there is no sudden drop in income late in retirement. This is, however, present in the case of the term nominal annuity, and to some degree also with the phased withdrawal.[5] A rather different pattern of income variation is implied by instruments, which expose the purchaser to investment risk. The variable annuity offers longevity risk cover but investment risk exposure; the phased withdrawal exposes the purchaser to both risks.

TABLE 5-1 Consumer Welfare and Public Liability for Alternative Retirement Payout Products (Individual Male aged 65)

	First Year Annuity Income ($)	*First Year Total Income ($)*	*EV ($)* $\gamma = 0.5$	$\gamma = 5$	$\gamma = 10$	*PV ($) Pension Guarantee Payouts*
A: Purchase Price $ 100,000						
Nominal	10,976	10,976	n/a	n/a	n/a	33,934
Variable	15,613	15,626	59,089	39,384	30,312	30,242
CPI-indexed	8,394	10,273	−6,519	−7,007	−7,376	33,286
Term	10,719	10,721	−2,333	−2,357	−2,366	48,033
Phased withdrawal	10,723	11,174	26,285	15,599	10,483	44,887
B: Purchase Price $ 200,000						
Level	21,951	21,951	n/a	n/a	n/a	3,747
Variable	31,226	31,226	79,530	4,335	−20,988	11,745
CPI-indexed	16,788	16,788	−3,409	19,430	55,447	0
Term	21,438	21,438	−5,383	−6,904	−9,098	27,949
Phased withdrawal	21,401	21,401	13,118	−25,057	−41,472	20,241
C: Purchase Price $ 300,000						
Level	32,927	32,927	n/a	n/a	n/a	505
Variable	46,839	46,839	103,713	−48,703	−88,152	6,284
CPI-indexed	25,181	25,181	1,181	54,100	153,035	0
Term	32,157	32,157	−18,831	−61,086	−91,226	27,933
Phased withdrawal	32,168	32,168	1,149	−84,579	−112,207	12,867

Source: Authors' computations.

The first message from Table 5-1 is the high value placed on the variable annuity by low-income individuals, or by those with low risk aversion. The variable annuity offers a significantly higher expected rate of return, and this is a preferred product for those who are less risk averse, or for low-income individuals heavily reliant on government benefit. Equally important is the pattern of government liabilities reported in the right hand column of the table. Again, for low-income individuals, the expected present value of government payout for the variable annuity is less than for the level annuity, and also for all other retirement instruments we consider. This occurs because at low incomes, the higher expected payouts from the variable annuity reduce government liability relative to instruments, which offer insurance across more dimensions of retirement risk. These latter instruments offer a lower payout than the expected income from a variable annuity.

For the more risk-averse high income groups, however, the variable annuity comes last. For these individuals, there is little downside protection from government support, because their expected retirement incomes lie above the safety net range. At the same time, their preferences are specified so that they have an intense aversion to income volatility resulting form the exposure to investment risk associated with a variable annuity. The CPI-indexed annuity is the preferred retirement instrument for the rich and risk-averse. The strong preference in our calculations for this annuity type, compared with market experience, where demand is consistently reported to be weak, is surprising. One possible explanation is that CPI-indexed annuities are offered with far higher loadings in the commercial market than level annuities, which inhibits demand.[6]

In general, the term annuity fares worst in terms of its appeal to consumers. This is probably because there is no consistency of exposure to volatility over time. For the first 15 years, a safe, smooth return is offered; this appeals to the very risk averse, while those less averse to risk miss out on the higher expected returns generated by products associated with riskier portfolios. After that time, there is a considerable movement in consumption flows, which the risk averse dislike. No matter how preference toward risk is specified, this product has unattractive features. Furthermore, the public pension payout associated with term annuity purchase is much higher than for the level life annuity. This product may, of course, score better if a bequest argument were incorporated into the preference function.

Given our "medium" assumption over phased withdrawal drawdown, the first year payout from the allocated annuity is not particularly high. But the EVs are such that the allocated annuity ranks second overall to the variable annuity, given a purchase price of $200,000. However, as with the term annuity, the expected present value of public pension payments are high, given that the retiree relies on these payments as their only income source later in life.

It is difficult to capture the phased withdrawal's appeal in the preference framework used here. It generates a significant value of expected bequests, and also leaves considerable discretion over capital drawdown for the duration of life expectancy. Neither of these features is captured in our preference function, yet both are valued by individuals.

Table 5-1 reports results that are substantively different in the degree to which first pillar support might be relied upon. For the base $200,000 case, Figures 5-1 and 5-2 reveal this clearly. The non-indexed annuity streams remain flat over time, but when combined with first pillar payouts, total retirement income increases over time as the increasing pension guarantee comes into play for the latter stages of the annuity payout.

Sensitivity of our findings to changes in the assumed values of parameters is reported in Table 5-2. The safe real rate of return and the expected rate of inflation are varied for the base case of a $200,000 accumulation. Results

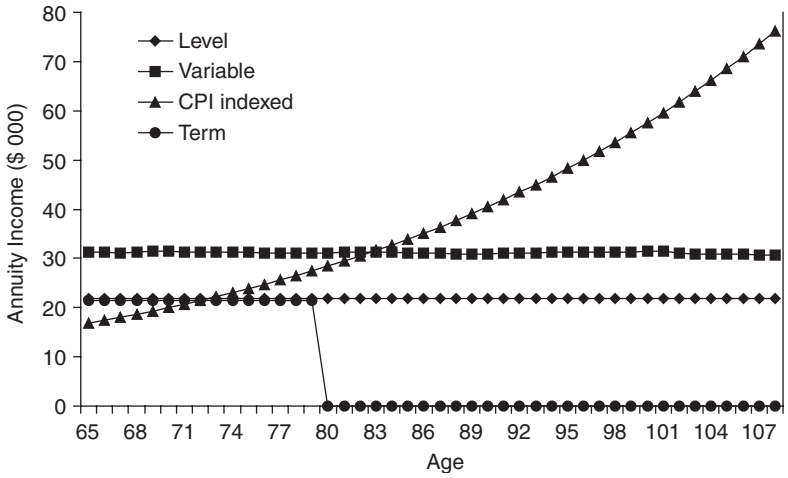

Figure 5-1. Expected annuity income paths. (*Source*: Author's computations.)

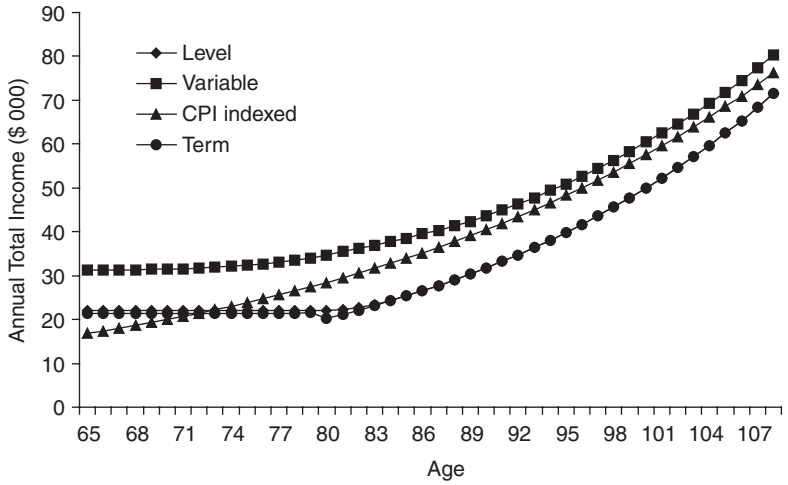

Figure 5-2. Expected total income paths with pension guarantee. (*Source*: Author's computations.)

suggest that first-year annuity payouts are quite robust across these ranges. When we turn to EV calculations, however, we find that some results are highly sensitive to the values of parameters assumed. Their interpretation requires a recognition that the payouts reflect both annuity income and first pillar government benefits. In most cases, rankings do not alter. Where

TABLE 5-2 Parameter Sensitivity Analysis: Inflation and Rate of Return

	2.5%			4.5%		
	First Year Income ($)	*EV ($)*		*First Year Income ($)*	*EV ($)*	
		$\gamma = 1.5$	$\gamma = 5$		$\gamma = 1.5$	$\gamma = 5$
A: Safe rate of return						
Level	20,382	n/a	n/a	23,542	n/a	n/a
Variable	31,226	74,358	20,070	31,226	37,526	−9,474
CPI-indexed	15,398	−5,017	9,779	18,284	6,388	28,665
Term	20,154	−2,618	−3,059	22,752	−8,560	−11,305
Phased withdrawal	21,401	16,331	−11,586	21,401	−12,710	−36,880
B: Inflation rate						
Level	20,382	n/a	n/a	23,542	n/a	n/a
Variable	29,320	53,328	1,244	33,159	55,412	6,798
CPI-indexed	16,643	2,046	13,438	16,954	−1,049	26,064
Term	20,154	−5,321	−8,548	22,752	−6,885	−7,162
Phased withdrawal	21,278	2	−26,959	21,525	601	−23,281

Source: Authors' computations.

Notes: Results reported for $200,000 premium, male 65-year old purchase.

reversals do occur, the explanation can in most cases be found in the relative impacts on first pillar support of relative changes in the payouts of the annuities.

EV values also appear highly sensitive to changes in the underlying real safe rate. The mechanism here relates to the level annuity benchmark. As the safe rate moves up or down, the relative importance of inflation and the equity premium change. For example, in the case of the variable annuity, an increase in the safe rate from 2.5 to 4.5 percent reduces the EV by half for individuals with γ set equal to 1.5, and reverses the ordering when γ is set equal to 5.

Because pension guarantee benefits are indexed to the real wage, the CPI insured instruments do best in limiting public liability, except for the low accumulation group. This public liability associated with non-indexed benefits increases with the expected inflation rate. For expected inflation of 4.5 percent, for example, the expected public liability associated with the variable annuity is $16,000, compared with $11,745 in the standard specification. As well, increases in the real safe rate reduce expected public outlays for instruments whose payouts are based upon safe returns. A level annuity is associated with an expected present value payout of $2,760 if

TABLE 5-3 Parameter Sensitivity Analysis: Equity Premium and Maximum Drawdown ($200,000 premium, male)

	Equity Premium 4%			*Max Drawdown Phased Withdrawal Annuity*		
	First Year Income ($)	*EV ($)*		*First Year Income ($)*	*EV ($)*	
		$\gamma = 1.5$	$\gamma = 5$		$\gamma = 1.5$	$\gamma = 5$
Level	21,951	n/a	n/a	21,951	n/a	n/a
Variable	33,104	66,716	10,688	31,226	54,742	4,335
CPI-indexed	16,823	1,385	20,266	16,823	1,385	20,266
Term	21,438	−5,632	−6,904	21,438	−5,632	−6,904

Source: Authors' computations.

Note: Results reported for $ 200,000 premium, male 65-year old purchase.

TABLE 5-4 Summary of outcomes for universal pension: Male $ 200,000

	First Year Annuity Payout ($)	*First Year Total Payout ($)*	*EV ($)*			*PV ($) Universal Pension*
Level	21,951	32,221	n/a	n/a	n/a	133,165
Variable	31,226	41,496	69,620	−27,025	−81,084	133,165
CPI-indexed	16,823	27,093	147	9,817	24,197	133,165
Term	21,438	31,708	−33,738	−114,196	−154,757	133,165
Phased withdrawal	21,401	31,671	−5,246	−68,489	−107,324	133,165

Source: Authors' computations.

Note: Results reported for $ 200,000 premium, male 65-year old purchase.

the real safe rate is 4.5 percent, compared with $3,747 in the central case specification. First year annuity payout variation, while small, can lead to major differences in first pillar liability.

Table 5-3 reports results from two further variations on our central case specification. Increasing the equity premium leads to higher payouts for instruments relying on risky portfolios. Altering the drawdown pattern of the phased withdrawal changes early year payouts, but also the later year reduction in private income.

Finally, we turn in Table 5-4 to consider the impact of a universal pension to sit beneath private retirement income, rather than a minimum pension guarantee, in which benefits are withdrawn dollar-for-dollar. The clearest

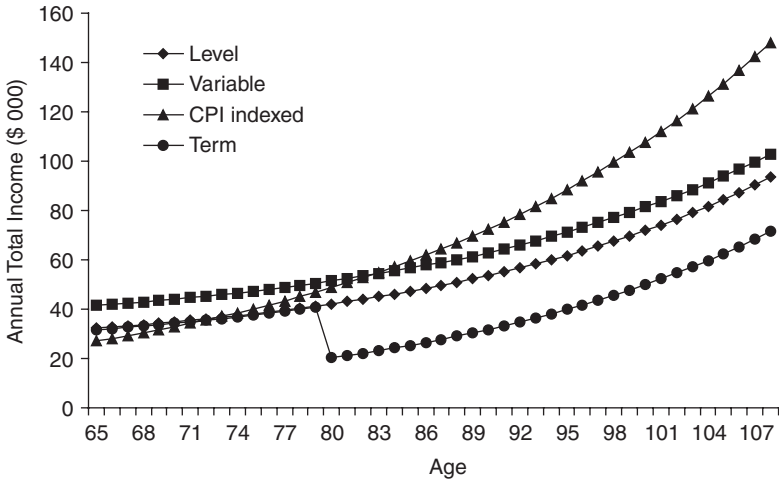

Figure 5-3. Expected total income paths with universal pension. (*Source*: Author's computations.)

impact is that government benefits and therefore retirement income flows, are higher across a wider range of wealth accumulations. These government benefits become more important later in life, as Figure 5-3 indicates.

Consumer preference across annuity types varies with this alternative first pillar design. The variable annuity retains its ranking as the most preferred product for the cases we consider, even though the risk-sharing inherent in the pension guarantee design considered earlier is no longer present. But the replacement of a guarantee with a fixed demogrant does reduce the desirability of the phased withdrawal, whose ranking across the five alternatives drops to fourth. Otherwise, however, the consumer preference ordering across products is the same as that generated in the pension guarantee case.

Conclusion

This chapter investigates the consumer preference and government budget implications of alternative annuity designs in a private mandatory retirement provision environment. We assume a retirement policy framework in which mandatory DC accumulations are paid out at retirement, and regulations over retirement income streams must be separately stipulated. A social welfare safety net is assumed, in which either a minimum pension is guaranteed by the government, or a universal social welfare payment is provided. The minimum pension is similar in broad structure to the US Supplemental Security Income Program (see for example Daly and Burkhauser, forthcoming), which offers a transfer to elderly US citizens or permanent residents

equal to about 25 percent of average full time earnings, subject to income and assets means tests.

The insurance coverage and payout profiles of several different annuity products are considered. Numerical simulation of annuity payouts for a 65-year-old male, in the presence of longevity, investment, and inflation risk, is used to gain insight into the implications for social welfare benefits and consumer preference valuation of alternative products by the retiree. We find that with a minimum pension guarantee, the variable annuity is the most preferred of all the annuities we study, for a broad band of accumulation levels and degrees of risk aversion. In some cases, the expected government outlays associated with first pillar obligations are also lower. These findings hold only for the lower accumulation groups, but in a policy context, these are perhaps the most important. Annuity mandation, and concern about government responsibility for individual welfare in retirement, is unlikely to be focussed on the rich.

Another broad finding is that inflation insured annuity products are popular, especially with the rich and risk-averse. As well, except for the poor, inflation-indexed products yield lower expected public liabilities than most other products. Finally, non-life instruments, especially when tied to risky investments, are popular, but they tend to be quite expensive for government revenue.

This chapter considers only two first-pillar safety net designs, which could be seen as two extremes between a variety of alternative tapered benefit structures. Other research not detailed here suggests that tapered benefits extend to higher income ranges the pattern of consumer preference and public outlays we report for the guarantee case. Extensions to our research could embrace alternative portfolio specifications, including especially portfolio insurance and protective put strategies, which offer some protection against downside risk; multiple individuals; and the implications of a preference specification in which habit formation is incorporated.

Notes

[1]Australia and Switzerland are among the developed nations to adopt mandatory policies, while among developing economies, Chile has the most mature system. More than a dozen countries, mostly from Latin America and the transition economies of central Europe, have either mandated private retirement provision or have stated their intention to undertake such reform. Further, a number of developed countries have either reformed their pension systems in this direction (e.g., the United Kingdom) or have debated doing so (the United States).

[2]This assumption is supported by evidence on the United Kingdom, Canada, and West Germany (Ely and Robinson, 1989), which suggests that in the short term, the correlation between the real stock return and the inflation rate are not significantly different from zero. Similar results hold for the Australian economy (Crosby, 1998).

[3]A worker on average earnings, who had been in full time employment continuously for 35 years to retirement in 2000, contributing 9 percent of earnings (the Australian mandatory rate), would have accumulated about $160,000 at retirement. Bateman and Piggott (1999) provide an account of the Australian mandatory Defined Contribution system, the Superannuation Guarantee.

[4]We assume a standard iso-elastic utility function, which allows for the incorporation of varying degrees of risk aversion.

[5]The possibility of reversion of the annuity to a spouse is ignored. Further, we ignore taxation and government benefit provisions, which specifically favor one annuity type over another.

[6]Our baseline drawdown assumption for the phased withdrawal is set halfway between the two extremes. In Table 4-4, we report the case of a phased withdrawal with maximum drawdown. This generates the same "over-the-cliff" drop as for the term annuity.

[7]This may be because of accentuated self selection in the indexed annuity market (only those with very long life expectancies care about inflation indexation), or because of a lack of long-dated indexed securities to provide insurers with suitable immunization against inflation risk.

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