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Mandatory Annuity Design: A Preliminary Study

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Abstract

This paper offers a preliminary exploration of the implications of alternative mandatory annuity designs in a privatized Social Security environment. We assume a retirement policy framework in which mandatory defined contribution accumulations are paid out at retirement, and regulations over retirement income streams must be separately stipulated. A means-tested social welfare safety net is assumed. This structure schematically represents the broad contours of retirement provision policy in Australia.

The insurance coverage and payout profiles of several different annuity products are considered. Numerical simulation of annuity payouts for a 65-year-old male is used to gain insight into their implications for social welfare benefits and the potential ranking of alternative products by the retiree. Results indicate that while a "standard" actuarially fair life annuity is likely to score well from both individual and social perspectives, products that offer only partial insurance against the major retirement risks—longevity risk, investment risk, and inflation risk—may dominate. There are, therefore, likely to be advantages in allowing some flexibility in mandatory annuity design.

1. Introduction

This paper explores the appropriate development of policy toward mandatory retirement income streams in a privatized retirement policy environment. Privatization of Social Security is under active consideration in the U.S., and reforms of this type are already well established in several countries, including Switzerland, Chile, and Australia.[1] The retirement policies operating in these countries all entail private-sector management of mandatory second pillar retirement accumulations. These are mainly of the defined contribution (DC) or accumulation type.

The associated payout profiles in these three countries, however, have thus far been conditioned more by the pre-reform retirement policy status quo than by dispassionate consideration of sensible policy design. Yet it is the retirement phase in which many of the financial risks associated with the elderly, which cannot be adequately insured against in an unregulated private market, are confronted. It is these, more than any other considerations, that underpin the economic case for central intervention in retirement provision in the first place.

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 privately administered retirement provision will require a policy position on the nature of retirement benefits. Under mandated, privately administered, defined contribution plans, regulations and employer obligations associated with the accumulation phase typically expire at retirement, and payout regulations must be separately stipulated. Throughout this paper we assume this arrangement will prevail.

Insurance against retirement risks, however, whether provided by governments or privately, is expensive, and successful policy design must be sensitive to these costs, and responsive to the subtle trade-offs between insurance and expected income that they imply. Although

[1]Several other Latin American countries, including Argentina, Peru, and Mexico, are introducing retirement policies of this kind.

our results are very preliminary, they suggest that regulations stipulating partial insurance may lead to social outcomes that are superior to those generated by a rigid full insurance regime.

We begin in Section 2 by suggesting criteria for retirement income policy design for policy paradigms that rely on mandatory second pillar accumulations. Section 3 outlines the approaches to payout policy adopted in the three exemplar countries, while Section 4 discusses the implications of adverse selection. Section 5 considers the relative merits of alternative retirement income designs. In Section 6 we report illustrative numerical simulations of annuity payout streams, followed by some preliminary calculations of policy implications in Section 7. Throughout the paper we draw mainly, although not exclusively, on the Australian experience.

2. Criteria for Retirement Income Policy Design

Criteria for assessing retirement income policy can be conveniently divided in two parts: those addressing the allocation and distribution of resources in the economy as a whole, and those directly relevant to the retiring individual. The latter criteria, which embrace various kinds of insurance, concern us here.

There are many sources of income uncertainty that a risk-averse individual confronting retirement would like to insure against. In the spirit of Bodie (1990), we list the following as among the most important:

- *Replacement rate risk.* Replacement rate risk is the possibility that the retiree will not have enough income to maintain a reasonable standard of living after retiring, relative to that which he enjoyed during his pre-retirement years.
- *Annuity rate risk.* The price of annuities will vary over time. If annuity purchase is mandated on retirement, then rest-of-lifetime income might be significantly affected by variations in the annuity rate.
- *Longevity risk.* Longevity risk is the risk that the retiree would exhaust the amount saved for retirement before he dies. One way people insure against this risk is by investing in life annuities. In the absence of a policy-compelling life annuity purchase, however, adverse selection can seriously limit retirees' effective access to this market.
- *Investment risk.* Investment risk is the possibility that retirement investment income flows will be uneven because the assets in which the accumulation is invested generate volatile returns.
- *Inflation risk.* Inflation risk is the risk of price increases that erode the purchasing power of lifetime savings.
- *Contingent outlay risk.* This is the risk that elderly individuals may have to outlay significant sums unexpectedly, late in their life cycle.
- *Default risk.* This is the risk that the annuity issuer is unable to deliver the promised payments. To provide contextual relevance, recall that a seller of an indexed annuity to a buyer aged 55 with reversion to a younger spouse is committed to indexed payouts over 40 years or more. Because of the long durations involved, and the impossibility of predicting inflation over such a period, default risk in this context is real.

Why should these risks be important to the retiree? The primitive assumption, borne out by empirical evidence, is that the typical individual likes to smooth his equivalent consumption, both between working and retirement and within retirement. The retiree would like to have enough retirement income on average and would like to insure against major variations in that flow.

Average retirement income will be influenced by coverage, contribution levels, and investment performance (captured by replacement rate risk) during the accumulation phase, and by the annuity rate at retirement. This will depend on annuity type and its going price (annuity rate risk). Variations in retirement income will be affected by longevity, investment volatility through retirement, and inflation (longevity, investment, and inflation risk).

Despite the importance of annuities for retirees, they have been little researched by economists, perhaps because of the prevalence of government-funded Social Security support in developed economies. This paper, therefore, is somewhat speculative. It considers what retirement income products might be best suited to the task of addressing the risks associated with retirement, and what restrictions should be placed upon mandatory products.

3. Current Benefit Design in Mandatory Schemes

To make discussion more concrete, it may be useful to briefly describe the benefit types available in Australia, Switzerland, and Chile.[2]

[2]Sections 3, 4, and 5 draw heavily on Piggott and Doyle (1998). Sources for the material presented in Section 3 include Bateman (1998), Bateman and Piggott (1997), Davis (1995), Hepp (1990), Edwards (1998), and Stanton and Whiteford (1998).

Australia

Until the advent of mandatory retirement provision coverage in 1992 (known as the Superannuation Guarantee), Australia was almost unique among developed countries in having no second pillar. Mandatory contributions, payable by employers, are being phased in and will rise to 9% of employees' earnings by 2002. They currently stand at 7%. Before this, voluntary private sector occupational superannuation had quite low coverage, and benefits were mostly drawn as a lump sum, rather than as an income stream.

The practice of taking lump sums has continued under the Superannuation Guarantee. About 85% of the value of superannuation benefits are paid in this form. About 10% is taken as an income stream, and the remainder is taken as a death, temporary, or permanent disability benefit. Although income streams are not compulsory, they are encouraged through a variety of tax incentives and first pillar means test provisions.

Retirement income streams that attract preferential tax or means test provisions can be broadly classified into *immediate annuities* (which may be purchased with a DC accumulation), *superannuation pensions* (from defined benefit [DB] plans), and phased withdrawals, which in Australia are called *allocated pensions and annuities.*

Recently amendments to first pillar means-testing arrangements have served to encourage what might be termed *life expectancy* products.[3] These must guarantee an income stream for the life expectancy of the retiree at the time of purchase. There can be no commutation or residual capital value. Retirement accumulations used for these purchases are not counted in the assets test, one of two means tests applied to the first pillar age pension.

Allocated products are the most popular form of income stream. The maximum draw-down limit is set with the expectation that the account will be exhausted by the age of 80, whereas under the minimum level the account will last indefinitely (subject to diminishing withdrawals).

Switzerland

Switzerland has traditionally had a standard OECD-type three pillar retirement support policy. In 1985 another component was added to the second pillar, the BVG, which is a privately administered compulsory occupational plan. This supplements the employment-related Social Security pension, which is financed by Social Security tax payments from employers and employees. The two plans combined aim to provide a total retirement pension of 60% of covered earnings after 40 years of contributions for the average worker. There is a means-tested social-assistance pension for those on very low Social Security pensions.

Contributions for the BVG are required from both employers and employees, with the employer to contribute at least 50%. The contributions vary according to gender and age and range from 7% of earnings for the young to 18% of earnings for those approaching retirement. There are additional contributions of 2–4% for survivors and disability insurance, 1% to allow for the indexation of benefits, 0.02% for the security fund, and 0.2% for administration.

Benefits from both Social Security and the BVG are generally paid as monthly pensions. Alternative benefit designs are not available. For small BVG accumulations, lump-sum benefits are possible, and early withdrawal of benefits for housing purchase is available under certain circumstances.

Viewed as a DC plan the BVG incorporates minimum requirements: a minimum contribution rate, minimum rate of return, and minimum annuity conversion factor. (Annuity factors must be gender-uniform.) The security fund guarantees minimum retirement credits, and by covering DC as well as DB plans, the Swiss guarantee arrangements are unique in the OECD. Reversion is required. Although the BVG is essentially DC based, many of the benefits actually paid exceed the minimum requirements and are formulated on a defined benefit (DB) basis.

Chile

Chile's current second pillar retirement income policy was established in 1981, with the old Social Security system gradually being phased out. It is of the DC type, publicly mandated but privately administered. The government guarantees a minimum pension to workers whose accumulations fall short of set limits. The value of the minimum pension is adjusted by inflation every time the accumulated change in the CPI reaches 15%. First pillar support comprises a targeted social assistance scheme. A subsistence pension is payable through that scheme to those not eligible for the minimum pension.

Retirees may make phased withdrawals from their individual account, regulated to guarantee income for

[3]Statistical life expectancy of an Australian male retiring at 65 is currently 15.49 years.

their expected life span, buy an annuity to provide lifetime benefits, or choose a combination. Programmed withdrawals require reversion, but life annuities do not. Some lump-sum withdrawals are permitted. However, this is allowed only if it still leaves enough in the account to fund a benefit that is a 70% replacement rate and equals 120% or more of the guaranteed minimum pension. Only 25% of the eligible retirees in Chile have taken lump sums. Of the current pension benficiaries of the new system, some 44% have taken up a lifetime annuity, although fees have tended to be high.

The phased or (programmed) withdrawal is one of the most common income stream products in Chile. Accumulated funds are drawn according to an actuarially determined schedule. Any balance remaining after the beneficiary dies is inherited by heirs. Complete longevity risk is provided only insofar as the government will pay the minimum pension if funds are exhausted.

4. Adverse Selection and Mandatory Annuity Purchase

One of the most intractable issues in annuity analysis is the extent and nature of adverse selection. The primary efficient market requirement that is violated is commonality of information; that is, the annuitant can be presumed to know more about his life expectancy than the annuity issuer. In a voluntary market this presumption leads to higher quotes on annuities than are actuarially fair for the population at large, and adverse selection sets in.

Major annuity issuers in Australia use mortality tables reflecting the longevity of voluntary annuity purchasers in pricing annuities, rather than general mortality tables. Annuitant mortality tables are apparently used everywhere that the purchase of life annuities is voluntary.[4] Quotes from a major financial service provider suggest that in August 1998, allowing for commission costs, a 15-year term certain annuity is priced using a nominal interest rate of 5%. Using standard Australian mortality tables, corresponding quotes for a life annuity for a male aged 65 imply a nominal rate of 2.5%. The difference in the implied rates of return partially reflects adverse selection.

Because of the compounding effect of discounting, the present value of a fixed single life annuity paying $1 a year will be lower than the present value of a $1 fixed term certain annuity where the term is set at life expectancy. The Australian quotes referred to above were (about) $9,500 a year for the life annuity, and $11,400 a year for the term certain annuity, for a purchase price of $150,000. The actuarially fair life annuity payout, assuming that the commission payments and rates of returns for the two contracts are identical, is more than $11,900.[5] Adverse selection has reduced the annual payout on the life annuity by about $2,400, or 20% of the actuarially fair value. Using a much more sophisticated methodology, Mitchell, Poterba, and Warshawsky (1997) report load factors on actuarially fair quotes of between 15% and 20% in the U.S. for 1995, although some of this is due to overhead costs.

For most retirees these load factors are an effective deterrent to voluntary life annuity purchase. They suggest that adverse selection is pervasive in individual annuity markets. Given that individual tailoring of annuity contracts is infeasible, there is a strong case for mandating life annuities. Adverse selection is very limited when everyone must buy an annuity, provided appropriate restrictions are placed on annuity offers. Compulsion may reduce commission costs, and in addition mandatory annuities address the possibility of preference inconsistency in arranging finances through retirement.[6]

Annuity mandation immediately raises the question of what features such instruments should have. In what follows we examine the implications of alternative annuity products, suggested by Australian experience, both from the perspective of the retiree and from the viewpoint of government outlays. For simplicity, we focus on a male average weekly earnings with statistically average life expectancy, an assumption justified by mandatory annuity purchase. Reversion is ignored. The analysis is conducted in a policy environment that guarantees means tested first pillar safety net support and mandatory private second pillar accumulations.

[4]These are usually derived from the experience of voluntary annuity providers. In Australia, where annuity experience is limited, U.K. annuitant mortality tables are used.

[5]These quotes encompass 3% escalation and no residual capital value.

[6]An alternative approach to limiting adverse selection has been put forward by Brugiavini (1993). She suggests incremental deferred annuity purchase throughout the accumulation phase, to exploit the observed feature of annuity markets, that adverse selection increases with age. A similar idea has been suggested by Boskin, Kotlikoff, and Shoven (1988). Incremental deferred annuity purchase would also serve to spread annuity rate risk, since the terms of annuity purchase would vary with each increment purchased (Bateman and Piggott 1999).

5. Alternative Annuity Designs and Retirement Risk Coverage

To keep analysis tractable, we have chosen to examine five annuity designs with varying coverage of the risks outlined in Section 2. A standard life annuity, in which payouts are graduated, or escalated, at 3% to partially offset expected inflation is used as a benchmark. Table 1 lists these annuities and reports their salient features.

Variable, or *with-profits,* annuities have been designed to 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 (the 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; in our calculations we have assumed an underlying portfolio of equities.

TABLE 1
ALTERNATIVE ANNUITY PRODUCTS

Annuity Type	Nature of Annuity Payout
Standard life annuity	Provides an income stream, escalated at 3% per year, until death.
"Life expectancy" annuity	Provides a prespecified income stream, escalated at 3% per year, over life expectancy at time of purchase.
Variable life annuity	Provides an income stream until death, with payments contingent on the market performance of some specified underlying portfolio. The AIR is set to generate an expected 3% escalation.
Phased withdrawal and deferred life annuity	Income can be drawn down at the retiree's discretion within a range specified by regulation; typically, maximum drawdown limits are set to exhaust resources by life expectancy from time of purchase. Deferred standard life annuity payments then commence; the deferred annuity is valued at 10% of the product purchase price.
Partial inflation indexation	Provides an income stream escalated at 3% with an inflation "deductible" providing a real protection factor of 85%; payments are indexed to inflation above this cumulative price level increase

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 draw-downs, however, are limited to a range, with both upper and lower bounds, depending on the life expectancy of the retiree when he purchases the phased withdrawal. The maximum draw-down factor is calculated on the basis that the individual will live his expected life span at the time of the purchase of the phased withdrawal. The minimum is calculated on the basis that he will survive until the actuarial probability of survival from the date of purchase approximates zero. These "draw-down factors" apply to the account accumulation each year. In Australia phased withdrawals are the fastest growing segment of an admittedly small retirement income product market.

These products have also been marketed with deferred annuities starting at age 80, although regulations now preclude this. This combination has considerable intuitive appeal, combining capital draw-down flexibility with partial longevity insurance. For the first 15 years the annuitant has considerable control over draw-downs. The deferred annuity then cuts in, offering a rest-of-life annuity with an initial payout indexed to inflation, thereafter escalated at a pre-determined rate. The annuitant bears the investment risk of the allocated pension but derives some inflation protection from the correlation between movements in the price of physical capital and the price level generally and enjoys insurance against investment risk under the deferred annuity. In the event of death before age 80 a bequest results.

The deferred annuity is not expensive: A 65-year-old male needs to commit only about 10% of his accumulation to the deferred annuity. This result occurs because of the combination of the probability of death before payouts begin, a lower initial payout, and the compounding of investment returns in the 15 years prior to the first payout. In addition, life expectancy at age 80 is only seven years.

It is possible to purchase annuities indexed to the CPI, that is, *CPI-indexed annuities,* at least in Australia and the U.K. Even a modest inflation rate of 4% will halve purchasing power in 18 years. Combined with 1% wage productivity growth, purchasing power relative to community standards will halve in 14 years. For a retiree with a life expectancy of 15 or more years, as a male retiring at 65 would have in Australia, erosion of purchasing power through inflation is thus a significant risk. For women the risk is even greater.

Escalated annuities partially address this problem, and escalation has been assumed in most of our numerical examples. However, this does not offer insurance against unanticipated inflation, which perhaps more than anticipated inflation "creep" is the larger danger to annuitant welfare, precisely because of its unpredictability. Formica and Kingston (1991) propose an annuity product offering inflation protection above some cumulative deductible. In periods of significant inflation and inflation volatility, this partial indexation allows significantly improved payouts relative to full inflation protection, while at the same time providing coverage against inflation surges.

All these products offer partial insurance against one or more of the major risk types identified in Section 2. Although private annuities can be designed to provide full insurance against longevity, investment, and inflation risk, such comprehensive insurance is very expensive. Quotes from the voluntary annuity market attest to this. In Australia fully indexed life annuities for 65-year-old males are offering a first-year payout of $7,000 for a $100,000 purchase price. Allowing for an up-front fee of 6% of purchase price, and a (currently high) expected inflation rate of 4%, the implied underlying real rate, assuming actuarially fair life expectancies, is still less than 1%. This offer, of course, reflects adverse selection, but it is no surprise that these annuities do not sell well.

Table 2 rates how well the degree of insurance coverage offered against various types of risk covers payout-related risks. The insurance coverage that each provides is rated as low, medium, or high. Because a term-certain annuity offers little longevity insurance, it is rated "low" on this category. In contrast, annuities with some longevity insurance features score better on this category. Those with life features score high, while the phased withdrawal, which offers some longevity insurance but admits the possibility of resource exhaustion prior to death, rates a medium.

Turning to investment risk, fixed annuities offer high coverage, as does a full CPI-indexed instrument. By contrast, annuities that leave the purchaser with most or all of the investment risk—variable annuities and phased withdrawals—score poorly here.

Inflation risk is not well covered by fixed instruments. It is fully covered by a CPI-indexed annuity and is partially covered by instruments in which the annual payout is related to the investment return of a portfolio representing claims on physical assets. We have rated a variable annuity low here, since there appears to be no easy way to reinvest part of a high nominal return in times of high inflation. By contrast, phased withdrawals provide a ready mechanism for such reinvestment, simply by drawing down a lower proportion of accumulated capital through such periods.

In one sense full coverage against these payout risks is desirable. However, as we emphasized earlier, it is expensive. This quickly exposes retirees to replacement rate risk. For a given accumulation the overall expected income stream will be lower, the more comprehensively these risks are covered. A CPI-indexed annuity is therefore rated as providing only medium coverage against replacement rate risk, while variable life annuities and phased withdrawals score better.

Annuity rate risk is determined by volatility in the relevant interest rate. Where the annuity rate depends on the nominal interest rate, coverage against annuity rate risk is low; where payout is tied more closely to the real interest return, coverage against annuity rate risk is high.

TABLE 2
DEGREE OF COVERAGE AGAINST INCOME UNCERTAINTY OFFERED BY ALTERNATIVE ANNUITY PRODUCTS

	Type of Risk				
Annuity Type	**Longevity**	**Investment**	**Inflation**	**Replacement**	**Annuity Rate**
Standard term	Low	High	Low	Low	Low
Standard life	High	High	Low	Medium	Low
Partial inflation indexation	High	High	Medium	Medium	High
Variable annuity	High	Low	Low	High	High
Phased withdrawal (with deferred life annuity)	Medium	Low	Medium	Low	Medium

Table 2 indicates that no annuity design dominates in all risk categories. Overall the pattern of insurance coverage suggests that partial exposure to some of these risks may be acceptable, in return for a higher expected income or consumption flow.

6. Calculating Mandatory Annuity Payout Streams

We calculate the income flows that different annuity types yield using variants of standard actuarial formulas. The general formula for the actuarially fair annuity payment for a standard life annuity is given by

$$y = K / \sum_{t=1}^{\omega} {}_tP_x \frac{(1+s)^{(t-1)}}{(1+R)^t}, \tag{1}$$

where K is the purchase price of the annuity, ${}_tp_x$ is the annuitant's probability of survival t periods from age x, s is the escalation factor, R is the risk free rate of return, and ω is set at the maximum potential life span, measured from the annuitant's age, given by x, at $t = 0$. A term annuity income flow is calculated using Equation (1), but setting ${}_tp_x = 1$ for all t, and ω equal to the term of the annuity.

Most of our calculations are deterministic, but in the case of the variable annuity we have undertaken stochastic simulation. This allows simulation of the investment volatility to which the annuitant is exposed with this product. The method is described below.

A variable annuity is written on the basis of an assumed investment return (the AIR). Payouts, however, are adjusted by the relationship between the performance of the underlying portfolio given by R^m and the AIR. The formula is

$$y_t = y_{t-1}\left(\frac{1+R^m}{1+AIR}\right), \tag{2}$$

where y_0 (not actually paid) is determined according to Equation (1).

The payout stream specification for a phased withdrawal can be formalized by specifying the account accumulation at time t:

$$K_t = K_{t-1}(1+R^m) - y_t. \tag{3a}$$

The payout at time t of a phased withdrawal may be written

$$\frac{K_{t-1}}{F_{t-1}^1} \le y_t \le \frac{K_{t-1}}{F_{t-1}^2}, \tag{3b}$$

where F_t^1 is the minimum drawdown factor, and F_t^2 is the maximum.

The initial deferred annuity payout is given by

$$y = \lambda K / \left\{\left[\frac{{}_dP_x(1+s)^d}{(1+R^s)^d}\right]\sum_{t=1}^{\omega-x} {}_tP_x \frac{(1+s)^{t-1}}{(1+R)^t}\right\}, \tag{4}$$

where λ is the proportion of the retirement accumulation dedicated to deferred annuity purchase (here set at 0.1), d is the term of the deferral, and R^s is the observed historical return on a balanced Australia superannuation investment portfolio (6.3% real).[7]

Specification of the income flows for annuities providing partial insurance against inflation is more complicated. Formica and Kingston (1991) discuss this in detail and provide the following formula for the payout in year t:

$$y_t = K / \left\{\sum_{t=1}^{\omega} {}_tP_x\left[\frac{(1-s)^{(t-1)}}{(1+R)^t} + c(t)\right]\right\}, \tag{5}$$

where $c(t)$ represents the cost of the (usually partial) inflation insurance.

Stochastic Simulation for Variable Annuities

In our stochastic simulations we measure time units in quarters, so that for a retirement of 44 years we have $t = 1, 2, \ldots, 176$. It follows that time measured in years will, in general, be given by t/j, where j is the number of fine time units that make up one year. Thus, for the quarterly units used here, $j = 4$. For the benefit of any reader interested in reworking our analysis with, say, monthly units, the subsequent development is given for the general case.

The stock of risky assets at time t is given by

$$x_t = \left[1 + \frac{1}{j}\left(\bar{\mu} + \frac{\sigma^2}{2}\right)\right](x_{t-1} - y_{t-1}) + \sigma\sqrt{\frac{1}{j}}(x_{t-1} - y_{t-1})\varepsilon_t, \tag{6}$$

where ε_t represents a draw from a standard normal distribution. Without the annuity payout y_{t-1}, x_t would describe (a discrete-time approximation to) geometric Brownian motion. This assumption is standard. Variable annuity returns are modeled using stochastic simulations. Each of

[7]Where a deferred annuity is specified, the sum available for the phased withdrawal is correspondingly reduced.

the reported experiments is based on 10,000 draws from a standard normal distribution.

Parameter Values

In the simulations reported here, we have assumed a retirement accumulation of $166,970. This amount would have been accumulated by a male earning average wages, contributing 9% of earnings to a pension fund for the last 35 years. Fund earnings are based on a balanced portfolio and average 11.8% nominal.

For the payout phase we have assumed a safe nominal rate of return of 8%, an expected inflation rate of 4%, a risky rate of return of 12%, and real wage growth of 1%. These values are broadly consistent with recent Australian experience. Taxation, through both accumulation and payout phases, is ignored.

In the current economic climate, an assumed 4% inflation rate may appear high, but this rate appeared appropriate, given the very long time horizons that are considered in some of the simulations. Ten years ago a 4% inflation rate would have appeared too low. Over this century Australian inflation has averaged 4%.

The above values imply an equity premium of 4%. This may be low by conventional standards. In a very thorough study, however, Siegel (1992) argues that over the last two centuries the equity premium may have been closer to 3–4% than to the 6–7% range frequently used. He suggests that the high equity premium observed over the 65 years up to 1990 was due primarily to depressed rates of return on fixed income assets, and that it is unlikely to endure in the future. Again, 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.

Specification of First Pillar Payouts

The first pillar payouts are specified to approximate Australian arrangements. The maximum pension is equal to 25% of male average weekly earnings; its current value is $9,290. Individuals can receive other income of up to $2,600, before pension income is reduced. Thereafter, a 50% taper applies. These amounts are indexed to wage growth, assumed to be 5% nominal.

Annuity Payout Streams

Table 3 reports annuity payouts and first pillar benefits for selected years using the procedures outlined above. In the case of the variable annuity, expected annuity and pension payouts are used. Estimated male average earnings are reported to provide a benchmark. First-year payouts vary from $16,406 to $23,332, a very broad range. However, the role of the first pillar in evening out income flows over time is readily seen. This occurs because although all annuity payments are escalated at 3% (expected escalation for the variable annuity) inflation is assumed to be 4% and real wage growth 1%. The wage-indexed pension becomes increasingly important with the passage of time from retirement.

7. Results

Direct comparison of income streams generated by different annuity products offers only a limited guide to their social merit. 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. All that is required of a utility score is that it ranks alternatives in the order of preference of the individual.

This approach is readily adapted to the present policy design problem. We adjust the income flows that 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.

We assume a standard iso-elastic utility function:

$$U_t(c_t) = \frac{1}{1-\gamma}(c_t^{1-\gamma} - 1) \quad (\gamma \geq 0, \gamma \neq 1), \tag{7a}$$

$$U_t(c_t) = \ln(c_t) \quad (\gamma = 1), \tag{7b}$$

and

$$c_t = \frac{y_t}{(1+\pi)^t}, \tag{8}$$

where c_t gives consumption in period t, y_t is the total retirement income, π is the inflation rate, and γ is a measure of risk aversion.[8] Utilities are discounted for

[8]Technically the coefficient of relative risk aversion.

TABLE 3
ANNUITY PAYOUTS AND PUBLIC PENSION ENTITLEMENTS BY ANNUITY PRODUCT (CURRENT $AUSTRALIAN)

	Year 1			Year 15			Year 25		
Annuity Type	Annuity	Pension	Total	Annuity	Pension	Total	Annuity	Pension	Total
Standard life annuity	$ 17,748	$ 1,781	$ 19,529	$ 26,846	$ 7,673	$ 34,519	$ 36,079	$ 16,323	$ 52,402
Term annuity (life expectancy)	16,406	2,452	18,858	24,816	8,688	33,504	0	29,961	29,961
Phased withdrawal with deferred annuity	18,415	1,382	19,797	28,691	3,824	32,515	21,920	23,193	45,113
Variable annuity[a]	23,810	167	23,978	37,511	7,027	44,538	51,771	15,814	67,585
Inflation indexed annuity with a 15% deductible	17,604	1,788	19,392	26,628	7,653	34,281	39,416	14,445	53,861
Estimated male average earnings		40,150				79,494			129,488

[a]Here we report expected values of both the annuity and public pension payouts. These values are not consistent with the deterministic calculation of public pension payout, given the reported annuity payout.

survival probability and time, and period by period utilities are aggregated to give an overall rest-of-lifetime score:

$$V = \sum_{t=1}^{\omega} U_{t,t} P_x \,/\, (1+\rho)^t, \tag{9}$$

where ρ is the discount rate, set at 5%.

For given revenue outlays, policy efficacy will be indicated by the utility score. If alternative designs incur varying revenue outlays, then these must be factored into the policy ranking. The present value of revenue outlays are calculated in each case according to

$$PV(T) = \sum_{t=1}^{\omega} \frac{T_t (1+\pi)^{(t-1)}}{(1+\rho)^t}, \tag{10}$$

where T_t gives the value of first pillar transfer in period t.

The crucial parameter in the preference function specification is the coefficient of relative risk aversion γ. The higher the value of this parameter, the more risk averse the individual's preferences. Traditionally quite high values of γ have been used, but over the last 10 years or so estimates of γ have fallen dramatically. In an influential study Stock and Wise (1990) report values of γ from an econometric study of the retirement decision of 1,500 salesmen. Values varied between about 0.2 and 0.4. Gourinchas and Parker (1997) estimate γ at about 0.5, and Shea (1995) reports estimates for high-income individuals that vary from 0.2 to 0.4. On the whole, therefore, we attach more importance to rankings where γ is set below unity.

Table 4 reports rankings for our menu of annuity products for values of γ ranging from 0.25 to 2. The present values of public pension outlays, and, where applicable, expected bequests are also reported.

The first important message from Table 4 is that a standard life annuity scores well, across a range of risk aversion parameters. Longevity risk spreading is important here, as is the gradual reduction of purchasing power over time, a pattern consistent with the time discount rate used. Associated first pillar pension payouts are in the middle of the reported range across annuity types. For those who are very risk averse, this is the preferred product.

The variable annuity, however, delivers these same features, with a significantly higher rate of return. For those who are less risk averse, this is a preferred product. Further, expected public pension payouts are very low, only about two-thirds of the expected payout under a standard life annuity. For the very risk averse, however, the variable annuity comes last.

At the other end of the ranking scale, the term annuity, a life expectancy product, scores very poorly. 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 that 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 about 50% higher than for the standard life

TABLE 4
INDIVIDUAL PREFERENCE RANKINGS ACROSS ANNUITY TYPES BY RISK AVERSION RANGE

	Standard Life Annuity	Term Annuity (Life Expectancy)	Phased Withdrawal with Deferred Annuity	Variable Annuity	Inflation-Indexed Annuity with a 15% Deductible
Risk aversion (γ)					
0.25	2	5	3	1	4
0.5	2	5	3	1	4
1	1	5	2	3	4
2	1	4	2	5	3
Present value of expected public pension outlays ($A)	31,423	44,508	29,986	22,218	30,942
Present value of expected bequests ($A)	–	28,436	27,847	–	–

annuity. This product may of course score better if a bequest argument were incorporated into the preference function.

One of the more innovative products to be developed for the Australian market combines a phased withdrawal with a deferred annuity. Notwithstanding the fact that this product does not exploit longevity risk spreading for a duration equal to the life expectancy of the purchaser, it has considerable appeal. It is difficult, however, to capture its appeal in the preference framework used here. It generates a significant value of expected bequests and leaves considerable discretion over capital draw-down for the duration of life expectancy. Neither of these features is captured in our preference function, yet both are valued by individuals. It should be noted that the stochastic nature of the phased withdrawal investment return is not recognized in our calculations. Expected public pension outlays are about the same as for a standard life annuity. Because the deferred annuity, when payouts begin, entail a reduction in consumption (about 16% in the present specification), the pattern of consumption is consistent with time discounting.

This last factor may go some way to explaining why annuities offering partial inflation insurance score so poorly.[9] An annuity offering inflation insurance with a deductible generates a payout profile whose real value reduces early in retirement and is thereafter insured against. Yet the opposite pattern will score better in a preference function with time discounting. There is also some anecdotal evidence that individuals prefer to front load their retirement payouts, presumably on the basis that they will be less active in their later retirement (see Hurd 1990).

Currently, inflation in developed countries is both low and stable. In such circumstances inflation insurance has little value. However, in a high-inflation and high-inflation-volatility era inflation insurance is valuable and expensive. Partial insurance, in which an annuity offers some real purchasing power protection beyond a deductible, can be much less expensive than full insurance.

Table 5 reports the impact on first-year payouts for a range of expected inflation rates and volatilities. With 2% volatility and 6% inflation, 80% protection allows a first-year payout more than 12% above a corresponding full insurance product. Our current calculations do not permit realistic utility comparisons of these alternatives, because we have not used a stochastic approach to inflation simulation.

8. Conclusion

This paper offers a preliminary exploration of the implications of alternative mandatory annuity designs in a privatized Social Security environment. We assume a retirement policy framework in which mandatory defined contribution accumulations are paid out at retirement, and regulations over retirement income streams must be separately stipulated. A means-tested social welfare safety net is assumed. This structure schematically represents the broad contours of retirement provision policy in Australia.

[9]Again we have not stochastically simulated inflation movements.

TABLE 5
THE IMPACT OF PARTIAL INFLATION INSURANCE ON FIRST-YEAR PAYOUTS FOR ALTERNATIVE EXPECTED INFLATION RATES AND VOLATILITIES* ($ AUSTRALIAN)

Real Value Protection Factor	Inflation Volatility		
	0%	2%	4%
(Expected inflation: 4%)			
100%	18,091	16,162	14,245
80	20,130	17,861	15,782
60	20,382	19,200	17,366
50	20,383	19,678	18,126
(Expected inflation: 6%)			
100%	18,423	17,123	15,263
80	21,394	19,288	17,107
60	22,905	21,185	19,086
50	23,153	21,933	20,070

Note: First-year payout for an actuarially fair single life annuity for a male age 65, valued at $166,970. Escalation is set at 2%. The nominal interest rate is assumed to be 9% and 11% for inflation rates of 4% and 6%, respectively, and the real rate is 5%. The first-year payout for corresponding uninsured annuities are $20,383 and $23,231.

The insurance coverage and payout profiles of several different annuity products are considered. Numerical simulation of annuity payouts for a 65-year-old male is used to gain insight into their implications for social welfare benefits, and the potential ranking of alternative products by the retiree. Results indicate that although a "standard" actuarially fair life annuity is likely to score well from both individual and social perspectives, products that offer only partial insurance against the major retirement risks—longevity risk, investment risk, and inflation risk—may dominate. There are, therefore, likely to be advantages in allowing some flexibility in mandatory annuity design.

Perhaps the most important reservation about choice in annuity products is that such flexibility may reintroduce in some degree the adverse selection difficulties that motivated annuity mandation in the first place. For example, if risk aversion and longevity are negatively correlated, then adverse selection may operate in both the standard and variable life annuity submarkets. How important this is must await further research.

Results are preliminary in other ways as well. The only series for which a stochastic process is modeled is stock market returns, and then only for variable annuities. A full analysis would incorporate stochastic processes for inflation and also, perhaps, nondiscretionary expenditure such as health care outlays. Alternative products could then be more completely evaluated against a full insurance product. The preference functions used do not embrace bequests as an argument, although the bequest motive is clearly important, and (unintended) bequests arise in our simulations. Nor do they value the option of varying income withdrawals, which some instruments allow. Further, no attempt has been made to price government risk.

In addition to addressing the above concerns, extensions to this 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 reversion requirement.

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