No. 0208

Social Protection Discussion Paper Series

Mandatory Annuity Design in Developing Economies

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May 2002

Social Protection Unit
Human Development Network
The World Bank

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* University of New South Wales. We are grateful to Edward Whitehouse and Robert Palacios who commissioned and edited the paper for the World Bank's pension reform primer series. We would also like to thank Hazel Bateman, Geoffrey Kingston, Sachi Purcal and Mike Sherris for extensive discussions and helpful comments. Matthew Williams provided inspired research assistance. Financial support under an Australian Research Council Grant and from the World Bank for related research is gratefully acknowledged.. All opinions remain the authors' own.

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ABSTRACT

This paper explores the appropriate development of policy towards mandatory retirement income streams within this broad framework, paying particular attention to the economic environments relevant to developing economies. After a review of existing practices, numerical simulation techniques are used to show how a modest, government-funded pension scheme and appropriate annuity design in the mandatory funded sector might sensibly be combined.

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Mandatory annuity design in developing economies

Suzanne Doyle and John Piggott

Pension policy has become one of the more volatile areas of economic reform in recent years. The onset of demographic transition, combined with concerns about the efficiency effects of a large public sector, has prompted a search for pension reform options that reduce governments' responsibility for direct financial support for the retired. This process is common to developing and developed economies alike.

A natural response is to find ways to increase self-provision of retirement income. This normally involves some minimum compulsory retirement saving, by either employees or their employers. The World Bank[1] has advocated such schemes, and a number of countries have adopted them. Australia, Switzerland and the United Kingdom are among the developed nations to adopt such mandatory policies explicitly, while among developing economies, Chile has the most mature system. A number of other Latin American nations have also followed this model, as have several transition economies.[2] The retirement policies operating in these countries all entail private-sector management of mandatory retirement accumulations. These are mainly of the defined contribution (DC) type. The substitution of individual pension accounts for at least part of social security has also been under active consideration in the United States.

Policies on payout profiles in countries with mandatory retirement accumulations, however, have thus far been conditioned more by the pre-reform policy *status quo* than by dispassionate consideration of sensible policy design. Yet, it is during the retirement phase that

1 World Bank (1994), Holzmann (1998).

people confront many financial risks against which the elderly cannot adequately insure themselves in an unregulated private market. The most important risks emanate from uncertainty about longevity, investment returns and inflation. It is these, more than any other considerations, that underpin the economic case for intervention in retirement provision in the first place.

This paper explores the appropriate development of policy towards mandatory retirement-income streams within this broad framework, paying particular attention to the economic environments relevant to developing economies. We begin with a brief review of retirement-benefit regulations in mandatory schemes. Broadly, we show that there is a strong tendency for mandatory retirement income streams to be associated with the defined-benefit (DB) paradigm, and in turn for the DB paradigm to be associated with unfunded public pension schemes. Where schemes follow a DC paradigm, benefits can usually be taken as lump sums, at least in some circumstances.

Consequently, the issues that arise in tying annuity-type benefits to a mandatory DC scheme have been under-researched. We introduce this topic in section 2 by discussing some broader regulatory and implementation issues concerning annuity markets which would need to be taken into account in implementing a mandatory annuity policy. Section 3 considers the potential market failures to which an unregulated and voluntary annuity market might be subject. In section 4, we provide an analysis of alternative annuity designs. Numerical simulation techniques are used to show how a modest, government-funded pension scheme and appropriate annuity design in the mandatory funded sector might sensibly be combined (sections 5 and 6).

1. A brief review of benefit policy

Widespread hardship among the elderly and dependence on charity motivated the development of organised retirement plans.[3] Best known, of course, are the public schemes that most OECD governments established some time ago. They typically pay a pension that

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2 See Palacios and Pallares-Miralles (2000) for a complete list.

3 See, for example, Samuelson (1987) and Costa (1999) on the United States and Hannah (1986) on the United Kingdom.

depends on years of service and earning levels and patterns. They are tax-financed, either from consolidated revenue, or from earmarked social-security contributions levied on earnings.

Income streams in retirement from public plans are usually indexed, at least to prices and sometimes to earnings (although the latter has become less common in recent years). They are guaranteed to last until death and frequently have generous survivors' benefits. These government promises and guarantees cover periods of many years. The growth and evolution of public pension systems have been intimately connected to the DB nature of the promise, and to its pension or annuity-type structure. If schemes had promised only lump sums at retirement, it is unlikely that they would have grown quite so much.

Given the magnitude of the liabilities of public pension schemes[4], both exacerbated and highlighted by demographic ageing, it is hardly surprising that there has been a retreat from these commitments. In various countries, 'parametric' changes to the promises made — involving pension ages, benefit indexation, survivor benefits — have resulted in reductions in the present values of future liabilities.[5]

The OECD countries are not alone in making these kinds of promises, however. Many other nations have given similar undertakings, although these promises have frequently been broken. In such cases, projections of liabilities carry less meaning. Financing and credibility problems in DB public schemes have led some countries in Latin America, Eastern Europe and the former Soviet Union to replace these structures with mandatory DC plans.

By contrast, some developing economies — often those with colonial links to the United Kingdom — have established provident funds to help finance retirement. These are essentially mandatory DC plans administered by the government, sometimes through a separately established board of management. The funds maintain individual accounts for employees and usually pay a lump sum at retirement, comprising the worker's net contributions and investment returns. However, they often allow for pre-retirement withdrawals — for housing or during unemployment, for example — which leave only small balances on retirement.

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4 On which see, *inter alia*, Palacios and Pallares-Miralles (2000), Table 4.2c, Kane and Palacios (1997) and Roseveare *et al*. (1996).

5 See Disney (1999*a*), Demirguç-Kunt and Schwarz (1999).and McHale (1999).

Whether compulsory DC plans are administered in the public or the private sector, however, they bring with them the policy challenge of associated payout design. That this is a controversial issue is evident from Table 1.[6] It reports a wide range of payout designs and provisions, and largely bears out the view that payout patterns reflect what has gone before.

To make discussion about payout design more concrete, it may be useful to describe briefly the benefit types available in Australia, Switzerland and Chile, the three countries with the most mature privately administered mandatory accumulation schemes.

1.1 Australia

Until the advent of mandatory retirement provision in 1992 (known as the superannuation guarantee), Australia was almost unique among developed countries in having only a means-tested public pension scheme. There was no mandatory second-tier pension, either of the earnings-related DB or the DC variety. The new scheme phases in compulsory contributions, payable by employers, which will rise to nine per cent of employees' earnings by 2002 (from seven per cent currently). Until 1992, voluntary private-sector occupational pension plans had quite low coverage, and benefits were mostly drawn as lump sums.

The practice of taking lump sums has continued under the superannuation guarantee. Lump-sum withdrawals account for about 85 per cent of the total value of benefits. About ten per cent is taken as an income stream and the remainder is taken in death or disability benefits. Although income streams are not compulsory, they are encouraged through a variety of tax incentives and the means test applied to the public pension scheme.

Retirement income streams that attract preferential tax and/or means test treatment can be broadly classified into three types. 'Immediate annuities' include both term-certain and life annuities. 'Superannuation pensions' are life annuities from DB schemes. The third category is phased withdrawals, which in Australia are called 'allocated pensions and annuities'.

Recently, amendments to means-testing arrangements have served to encourage what might broadly be termed 'life-expectancy' products. These must guarantee an income stream for the life expectancy of the retiree at the time of purchase. There can be no commutation or

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6 The table draws on Bateman (1997), Bateman and Piggott (1997), Davis (1995), Hepp (1990), Feldstein (1998), Barrientos (1998), Quessier (1998), and Stanton and Whiteford (1998).

residual capital value. Retirement accumulations used for these purchases do not count for the purposes of the assets test, one of two means tests applied to the public pension.

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

1.2 Switzerland

Swiss occupational pension plans have long had relatively broad coverage, but this has expanded further since they were made mandatory for all employees above a certain earnings level in 1985. These plans supplement the public pension, which consists of a DB plan with benefits related to average earnings and years of contributions and a means-tested safety net. The two schemes combined aim to provide the average worker with a total pension of 60 per cent of covered earnings after 40 years' contributions.

Usually both employers and employees contribute to the mandatory occupational schemes. The employer must contribute at least half of the total. Minimum contributions vary with sex and age from 7 per cent of earnings for the young to 18 per cent for workers approaching retirement. There are additional contributions of between two and four per cent for survivors' and disability insurance, one per cent to allow for benefit indexation, 0.1 per cent for the guarantee fund and around 0.4 per cent for administration and investment management.

Benefits from both the public and private components are mainly paid as lifetime pensions. The public pension is indexed to the average of price inflation and growth in nominal wages, while occupational schemes uprate benefits on an *ad-hoc* basis, depending on the strength of the scheme's finances. Small pension-fund accumulations, however, can be taken as lump sums and early withdrawal of benefits for housing purchase is available under certain circumstances.

Swiss occupational pensions must make minimum contributions, pay a minimum nominal rate of return on pension accounts and use a minimum annuity conversion factor that is sex-uniform. Together these requirements introduce a substantial DB component, similar to so-called 'cash-balance' plans in the United States.[7] Many schemes offer more than the mandatory minimum benefit, and some are based explicitly on a DB formula.

1.3 Chile

Chile's current retirement income policy dates from 1981. Mandatory second pensions are of the DC type, publicly mandated but privately administered. The government guarantees a minimum pension to workers whose accumulations fall short of set limits. This minimum is uprated by price inflation every time the accumulated change in the consumer price index reaches 15 per cent. The residual public system of 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 their expected life span; or buy an annuity to provide lifetime benefits; or choose a combination. Phased withdrawals require reversion, but life annuities do not. Some lump-sum withdrawals are permitted but only if they leave enough in the account to fund a benefit with a 70 per cent replacement rate and worth at least 120 per cent of the guaranteed minimum pension. Only 25 per cent of eligible retirees in Chile have taken lump sums. Of the current pension beneficiaries of the new system, 44 per cent have taken a lifetime annuity.[8] Fees, however, have tended to be high.

The phased withdrawal is one of the most common income-stream products in Chile. An actuarially determined schedule sets out how funds can be drawn down. The member's

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7 On which, see Schieber, Dunn and Wray (1998). There are also similarities to the 'notional-accounts' systems in Latvia, Poland and Sweden, which mimic the benefit formual of a DC plan but in fact are closer to a DB scheme. These schemes, unlike the Swiss occupational plans, are publicly provided and pay-as-you-go financed. See Disney (1999*b*).

8 It is important to note however, that most of these annuities were required because the individuals retired early and annuitization is mandated in this instance. See Palacios and Rofman (2000).

estate receives any balance remaining on death. The government's guarantee of the minimum pension when funds are exhausted provides a limited degree of insurance against longevity risk.

Table 1. **Retirement benefits in countries with mandatory accumulation retirement policies**

	Australia	*Switzerland*	*United Kingdom*
Pension age	55 for both men and women, to be increased to 60 by 2025	65 for men and 62 for women, the latter to be increased to 64 by 2003. Early access to accumulated benefit for home purchase	65 for men and 60 for women, the latter to be increased to 65 by 2010
Benefit type	Accrued benefits available either as a lump sum or as an income stream. Mostly taken as lump sums. Phased withdrawals ('allocated' pensions) are most popular form of income stream	Benefits paid as monthly pensions. Lump sums available if small accumulation or for home purchase. No income stream choice	Benefits from mandatory accumulation must be taken as an indexed annuity. Annuitisation can be delayed until age 75 with phased withdrawals until then
Reversion	Not compulsory	Reversion required	Reversion required
Replacement rate	40-year employment history, retiring at 65 generates 76% replacement for single man including both annuity and public pension income	Total replacement rate at average earnings of 60%, including 20% from private pension after 40 years of contributions	Varies by cohort
Integration with public safety net	Poor integration. Pension age not co-ordinated with public pension eligibility. Dissipated lump sum not counted under means tests	Well integrated with public pensions. Minimum pension guaranteed through means-tested top up	Well integrated with public pensions
Taxation	Lump sums taxed at 15% above an indexed threshold. Annuities and superannuation pensions taxed as ordinary income for all types of schemes, subject to 15% tax rebate	Benefits subject to income tax, including lump sums	Benefits subject to income tax

Table 1, continued

	Argentina	*Chile*	*Colombia*
Pension age	65 for men, 60 for women	65 for men and 60 for women 60. Early retirement permitted for high accumulations.	62 for men and 57 for women. Early retirement possible for high accumulations
Benefit type	Choice of phased withdrawals and life annuity. 'Fragmented withdrawals' available for accumulated funds too small to allow for withdrawals equivalent to half the basic pension. Lump sum withdrawals permitted for high accumulations. Variable annuities are allowed and common.	Choice of phased withdrawals and life annuity. Lump sum withdrawals permitted for high accumulations. Phased withdrawal compulsory if annuity greater than minimum pension is unaffordable. Most retirees so far have taken life annuities	Choice of phased withdrawals, life annuity, or a combination. If accumulated balance finances a pension of at least 110% of minimum wage, excess capital may be used for purposes other than retirement
Reversion	Dependants of a worker who dies before retirement entitled to survivors' pension of a proportion of worker's average income in the five years prior to death	Reversion required	Reversion required
Replacement rate	Depends on accumulation. Universal pension of about 27.5% of average earnings. PAYG benefits paid as percentage of average last 10 years' earnings for each year of contributions	Average replacement rates are 78% and higher for people opting for early retirement (82%)	Depends on accumulation. Minimum pension gives a replacement rate of around 60% of average earnings
Integration with public safety net	Well integrated with universal basic pension	Well integrated with safety net. Minimum guaranteed pension to those with 20 years employment	Government guarantees minimum pension (one minimum wage, or about 60% of average earnings) after 22 years of contributions
Taxation	Benefits subject to income tax.	All of the pensions are subject to income tax, but tax-free threshold is high	Pension benefits are tax-exempt up to the limit of 20 minimum wages. However, if funds are used for non-retirement purposes, taxes are due

Table 1, continued

	Mexico	*Peru*	*Uruguay*
Pension age	65. Early retirement possible for high accumulations	65 for men and women. Early retirement possible for high accumulations	60 for men and 55 for women, rising to 60 by 2003
Benefit type	Option of life annuity or phased withdrawals after 24 years of contributions. Government minimum pension guarantee applies. No guarantee if fewer than 24 years of contributions and option of either lump sum withdrawal, annuity or phased withdrawal	Choice of phased withdrawals and life annuity. Also third option combining temporary phased withdrawals with a deferred annuity	Life annuity only
Reversion	Reversion required	Reversion required	Reversion required
Replacement rate	Depends on accumulation. Minimum pension of one minimum wage (about 40% of average earnings) for those who satisfy contribution requirement	Depends on accumulation. Early retirement possible if the balance accumulated can finance a pension equivalent to 50% of average salary during last 10 years	Depends on accumulation. Minimum pension guarantee of at least 50% of last 10 years' average salary, rising if retirement is postponed. Funded scheme benefits depend upon level of accumulation
Integration with public safety net	Minimum pension guarantee	No public pillar or minimum pension guarantee	Minimum guaranteed pension payable after 35 years of contributions at retirement age or from age 70 with 15 years of contributions
Taxation	Withdrawals not taxed up to a limit of nine times the minimum wage. Higher limit for tax exemption when employees withdraw the whole balance at once	Pension contributions are paid out of after-tax income and pension benefits are also taxed.	Benefits subject to income tax.

Table 1, continued

	Malaysia	*Singapore*
Preservation age	Full benefits at 55, partial benefits at age 50. Early withdrawals permitted for home purchase	60 for men and women. Lump sum may be available at 55
Benefit type	Benefits can only be taken as lump sums. However the member can withdraw the annual dividend only or leave the funds in the account after age 55 and continue to contribute	Retirement account funds must be used to purchase a pension or annuity. Members may withdraw a lump sum at age 55 provided they retain a specified minimum sum in their retirement account
Reversion	Full accumulation available to beneficiaries if member dies	Full accumulation available to beneficiaries if member dies
Replacement rate	The average amount of the full withdrawal is about the same as an average annual earnings	Scheme intended to provide income of 20-40% of pre-retirement earnings, sufficient funds to meet medical expenses during retirement, and a home commensurate with income level
Integration with public safety net	No public pension. Means-tested benefits for over 60s with low provident fund accumulation and no family support	Strict means-tested safety net for people with low provident fund accumulation
Taxation	Benefits not taxed	Lump sum withdrawals at 55 tax-free. Pensions paid from age 60 also tax free, but any pension amount paid from contributions in excess of mandatory income are taxable

2. Infrastructure for secure private retirement income streams

For the market to allocate resources efficiently in a sophisticated society, three prerequisites can be identified:

- property rights must be allocated and enforceable;
- information about possible transactions must be fairly widely available; and
- contracts must be enforceable over time.

These requirements lie behind the legal, administrative and regulatory environment that must develop to support a comprehensive annuity market.

Viewed from this perspective, it is easy to see why the regulation of annuity issuers is so pervasive, and why it assumes so much importance. Property rights to pensions are frequently blurred by public regulations and complicated vesting rules. Relevant information is not available equally to annuity buyers and sellers. Very long time periods can elapse between annuity purchase and the final payment promised by the annuity issuer, thus raising the real possibility of default, either explicitly or implicitly through changes in the interpretation of contingent obligations.

Robust legal and reliable financial infrastructures are features of most developed economies. Otherwise, it is hard to see how market channels could facilitate long-term saving and investment. Mitchell (1998), Vittas (1999) and World Bank (2000*a*) are accessible discussions of these issues, emphasising the evolving nature of legal and financial infrastructure. This is important, not only in thinking about practical implementation, but also in understanding how public confidence in such structures — a necessary condition for a successful retirement saving policy — may gradually be developed.[9]

2.1 Administrative reach

Mitchell (1998) also points to the importance of record keeping.[10] The administrative reach of any retirement provision policy — and, by implication, the extent of coverage — will obviously depend on official awareness of potential beneficiaries. At present, most developing countries' schemes reach only a small proportion of the

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9 See also Whitehouse (2000) and Chlon (2000) on this question.

population. Contributors are typically around 80 per cent or more of the working-age population in OECD countries. However, average coverage in the transition economies is around a half, less than a third in Latin America and under 10 per cent in most of Sub-Saharan Africa.[11]

Developing countries' pension systems were often aimed at the urban workforce when they were introduced, rather than the working population as a whole. As these countries develop, it is likely that the urban labour force will become proportionately more important, so that coverage will tend to rise automatically over time. At the same time, however, the 'informal' urban workforce has been increasing in many of these economies, partly to avoid pension contribution and tax obligations.

2.2 Financial infrastructure

Financial infrastructure comprises legal and accounting procedures, the organisation of trading and clearing facilities, and the regulatory structures that govern the relations among the users of the financial system. Merton and Bodie (1995) point out that successful public policy in this (and other) areas depends importantly on recognising what it is that governments can and cannot do to promote economic efficiency. At a minimum, a regulatory framework for a robust banking system (and related institutions) seems essential for annuity provision to be reliable. Intermediation across time, size, and risk — all functions of the banking sector — is exactly what people planning for retirement require, along with confidence in the institutions undertaking the intermediation on their behalf. In addition, the existence of a well-functioning stock market is likely to encourage greater diversification of investment, and thus improve the performance of the pension system in both the accumulation and liquidation phases. Numerous empirical studies of stock market returns have documented the gains in diversification from investing internationally.[12]

While international diversification is very desirable, there are often strong pressures to invest domestically, even in developed economies. If these pressures prevail, then, in the absence of a domestic stock market, the result is usually that domestic government bonds

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10 See also Rofman and Demarco (1999) and Demarco, Rofman and Whitehouse (1998).

11 Palacios and Pallares-Miralles (2000), Tables 4.1, 4.7, 4.15 and 4.26. See also Iyer (1993), Cuesta, Holzmann and Packard (2000) and James (1999) on this issue.

12 See, for example, Holzmann (2000).

dominate pension fund portfolios. Government bonds in developing countries are rarely indexed. Thus, the erratic inflation performance of many developing economies puts at risk the real value of accumulations as well as the performance of securities underlying annuity issue.[13]

Derivatives have a useful role to play in pension reform in developing economies. These markets are often incomplete are the moment, but this will improve in the future. Given the pressure to invest domestically, exchange-rate risk, which is significant in many developing economies, might be insured against through foreign currency options. In the present global financial structure, however, such a strategy could presently be implemented only by over-the-counter negotiations, and it is unlikely that very large values of these options could be purchased.

Another suggestion for derived international diversification, due to Merton (1992), may have relevance for those countries with functioning stock markets. If capital controls (a form of domestic investment pressure) are taken as given, portfolios can be diversified internationally by separating capital flows from risk sharing using a swap-type agreement. In such a swap, the total return on a small country domestic stock market would be exchanged annually for the total return per dollar on a market-value-weighted average of the major world stock markets. This exchange of returns could be in a common currency or adjusted to different currencies along lines similar to currency swap agreements. As with most swaps, there is no initial payment by either party to the other for entering the agreement.

The swap agreement effectively transfers the risk of the small-country stock market to foreign investors. It provides domestic investors with the risk-return pattern of a well-diversified portfolio. Since there are no initial payments between parties, there are no initial capital flows into or out of the country.

2.3 Regulation of life insurance and annuity providers

Annuity issue raises a number of specific regulatory concerns, addressed in the quite sophisticated mechanisms developed economies use to govern annuity issuers. This group of agents typically overlaps heavily with life-insurance companies.

13 See Asher (1998) for a discussion of these issues in the context of provident funds in Asia.

Life-insurance regulations usually cover professional competence, reporting and disclosure requirements, reputation, and capital adequacy (or solvency). Credible regulatory authorities must be set up in countries contemplating the development of private life insurance and pension industries to ensure that annuity issuers meet these requirements. Often, the public sector will already be supplying these services. Effective privatisation of, or the introduction of private competition in, annuity provision should be implemented in ways that allow regulatory authorities to draw upon information already available from these public-sector activities (Mitchell, 1998).

The sequence of privatisation and deregulation therefore needs to be carefully considered. Annuity providers are typically licensed and are limited in number. The optimal privatisation path might require tight regulations initially, with gradual deregulation as the market matures. For example, registered annuity issuers could each be allocated a basket of contracts, with price and conditions set by the regulator. Subsequently, migration between issuers at regulated transfer fees may be permitted, followed by some price deregulation. The Chilean approach of gradual deregulation of pension funds' portfolios provides a natural parallel. Equity investments were not permitted until 1985, were restricted to 30 per cent of the fund's assets between 1985 and 1995 and have since been limited to 37 per cent. Some international investment is also now allowed.[14]

In many developing countries, life insurers are protected from international competition. Outreville (1996), for example, reports that of 48 developing countries in his sample, 11 had a monopolistic life insurance market, 14 insisted on some degree of local ownership, and 17 required that life insurance be purchased from local issuers. Only six enjoyed an offshore market. The prevalence of protectionist policies is apparently motivated by externality and infant-industry considerations.

However, constraints that local issuers in many developing economies must face — for example, under-capitalisation and lack of institutional experience and skilled personnel — create dependence by these institutions on international services. Protectionist policies thus seem likely to hinder, rather than aid, the development of the industry, and thus the effective provision of retirement-income products.

14 See Srinivas, Whitehouse and Yermo (2000).

For at least some developing economies, offshore annuity issuers could be contracted to develop the national market. An international tender process could be set up to provide annuity income streams for each cohort of retirees. It may be that international organisations (such as the World Bank and the International Monetary Fund) can be instrumental in establishing regulatory frameworks and monitoring their operation, and that this will help credibility. Buttressed by appropriate legal and financial structures, such support could be instrumental in promoting confidence in institutions supplying annuity products.

3. Adverse selection and mandatory annuity purchase

One of the most intractable issues in the analysis of private annuity markets is the extent and nature of adverse selection. The primary efficient-market requirement that is violated is commonality of information, that is, annuitants might know more about their 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.

Mitchell *et al.* (1999) analysed the money's worth of nominal lifetime annuities offered in the voluntary private market in the United States in 1995. They conclude that there is an average loading on single lifetime annuities of 18 per cent. For a typical 65 year old male retiree with average mortality prospects, $1 worth of premium used to purchase an annuity will return an expected present discounted value of around 84 cents. Some of this loading is due to adverse selection, and some to overhead costs. Adverse selection accounts for around 10 per cent of this loading.

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.[15] 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 per cent. Using standard Australian mortality tables, corresponding quotes

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15 These are usually derived from the experience of voluntary annuity providers. In Australia, where annuity experience is limited, annuitant mortality tables of the United Kingdom are used.

for a life annuity for a 65-year-old man imply a nominal rate of 2.5 per cent. The difference in the implied rates of return partially reflects adverse selection.

Because of effect of discounting compounds, 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 payout from a life annuity — assuming that the commission payments and rates of returns for the two contracts are identical — is more than $11 900.[16] Adverse selection and administrative charges have reduced the annual payout on the life annuity by about $2 400, or 20 per cent of the actuarially fair value.

These load factors imply that adverse selection might be pervasive in individual annuity markets. Given that individual tailoring of annuity contracts is infeasible, there is a strong case for mandating life annuities. As Walliser (2000) argues, adverse selection is very limited when everyone must buy an annuity, provided there are appropriate restrictions on annuity offers. Finkelstein and Poterba (1999) have shown that the loading on compulsory annuities in the United Kingdom are half the loading in the voluntary annuity sector. Compulsion may reduce commission costs, and in addition, mandatory annuities address the possibility of preference inconsistency in arranging finances through retirement.[17]

Mandating annuities 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 on some multiple of average weekly earnings with statistically average life expectancy, an assumption justified by mandatory annuity purchase. We ignore reversion. The analysis is based on a 'multipillar' pension system. The second pillar is a mandatory contribution to a

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16 These quotes include 3 per cent escalation — standard in Australia — and no residual capital value.

17 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 *et al.* (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).

private DC plan, the first pillar, a safety-net minimum total income guaranteed by the government.

4. Characterising life annuity products

Table 2 lists the five different income streams on which we focus, and reports their salient features. The first type listed is the conventional nominal life annuity. The standard life annuity has an escalation factor of three per cent. Other annuities have been modelled with this feature where appropriate. The 'life-expectancy' annuity is a term-certain annuity set to expire at life expectancy: about 15 years for a man aged 65. Other annuities require further explanation.

Table 2. **Alternative annuity products**

Annuity type	*Nature of annuity payout*
Nominal life annuity	Provides an income stream, constant in nominal terms, until death
'Life-expectancy' annuity	Provides a pre-specified income stream, constant in nominal terms, 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. Assumed investment return set to generate an expected constant nominal income flow
Phased withdrawal	Income can be drawn down at the retiree's discretion within a range specified by regulation; typically, maximum draw-down limits are set to exhaust resources by life expectancy from time of purchase
Inflation indexed	Provides an income stream with payments indexed to inflation until death

Variable annuities 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 a premium of two per cent.

The *phased withdrawal* appears at first sight to be more like a pure investment instrument than a retirement income stream product. The accumulated fund remains invested in a broad portfolio, over which the retiree has considerable control. The retiree can draw down both income and capital. The draw-downs, however, are limited to a range, with both upper and lower bounds, depending on the life expectancy of the retiree when they purchase the phased withdrawal.[18] 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 aims to maintain some capital 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 market for retirement-income products.

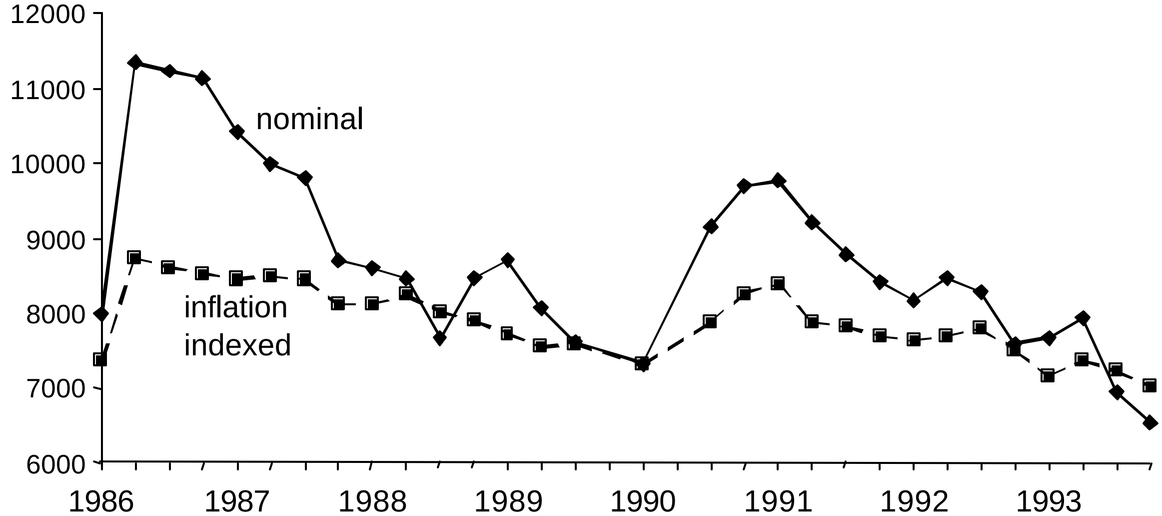
Inflation indexed life annuities. Even a modest inflation rate of five per cent will halve purchasing power in 14 years. Combined with three per cent wage (productivity) growth, purchasing power relative to community living standards will halve in nine years. For a retiree with a life expectancy of 15 or more years, erosion of purchasing power through inflation is thus a significant risk. For women, the risk is even greater.

Escalating annuities partially address this problem. But they do 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. It has been possible to purchase annuities indexed to the consumer price index (*CPI-indexed annuities*) in Australia and the United Kingdom for some time and, more recently, in the United States.

The price of CPI-indexed annuities tends to be much more stable over time than the price of nominal annuities, because the real interest rate is less volatile than the nominal rate. This should be borne in mind when comparing the two. Chart 1 shows both fixed and CPI-indexed annuity quotes in Australia from 1986 to 1993, a period of changing inflationary expectations[19]. The chart clearly shows the relative instability of the fixed annuity quotes over this period.

18 The drawdown factors are the same for male and female annuitants.
19 The fixed life annuity is calculated with an annual fixed rate of escalation of 3 per cent.

Chart 1. **Annuity rate variability in Australia, 1986-1993**
(annuities, men aged 65)



5. Calculating mandatory annuity payout streams

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

$$y = K / \sum_{t=1}^{w} {}_t p_x \frac{(1+s)^{(t-1)}}{(1+r)^t} \tag{1}$$

where K is the purchase price of the annuity ${}_t p_x$ 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 nominal life annuity with no escalation is calculated using (1), but setting $s = 0$.[20] Life-expectancy term-certain annuity payouts are calculated using the same formula, with ω set equal to life expectancy, and ${}_t p_x$ set equal to unity for all t.

20 For simplicity, these formulae (and equations 3a and 4) ignore the time subscripts on rates of return.

A variable annuity is written based on 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), with *r* set equal to the value of the AIR, and *s*=0.

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

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

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 draw-down factor, and F_t^2 is the maximum.

Specification of the income flows for annuities providing CPI protection is more complicated. Formica and Kingston (1991) discuss this in detail. A term reflecting the cost of inflation insurance, *A(t)* —calculated from the Black-Scholes option pricing formula — is simply added to the summed term in equation (1).

5.1 Stochastic simulation specification

The stochastic processes we assume for the rates both of inflation and of real investment returns follow geometric Brownian motion. The indices associated with both variables grow at trend rates that 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 returns processes are independent. This assumption is supported by empirical evidence for Australia, which suggests that the short-term correlation between the real stock return and the inflation rate is not significantly different from zero (Crosby, 1998). Similar results hold for the United Kingdom, Canada and West Germany (Ely and Robinson, 1989).

Formally, the process can be represented by

$$\frac{dX_i}{X_i} = m_i dt + s_i dW_i \qquad i = 1, 2 \tag{5}$$

where X_1 is the value of the inflation index, and X_2 the value of the real risky accumulation index, m_i is the mean rate of change, and s_i^2 is the corresponding variance.

The nominal risky rate is obtained via Ito's lemma, and is given by

$$\frac{dX_1X_2}{X_1X_2} = (m_1 + m_2)dt + s_1 dW_1 + s_2 dW_2 \tag{6}$$

The real return and inflation indices were generated by discrete approximations to the above processes. Drawing on a standard result in mathematical finance, valid approximations to (5) are given by:

$$\frac{\Delta X_{it}}{X_{it}} = m_i \Delta t + s\sqrt{\Delta t}\ e_{it} \qquad i = 1,\ 2 \tag{7}$$

where $e_{it} \sim N(0,1)$ and independent, and we measure time units in quarters, so that for a retirement of 44 years, we have 176 periods (because we assume retirement at age 65 and a maximum lifespan of 109 years). It follows that the nominal risky rate is given by:

$$\frac{\Delta(X_{1t}X_{2t})}{X_{1t}X_{2t}} = (m_1 + m_2)\Delta t + s_1\sqrt{\Delta t}\ e_{1t} + s_2\sqrt{\Delta t}\ e_{2t} \tag{8}$$

The stock of risky assets at period j is given by:

$$x_t = \left[1 + \frac{1}{j}\left(\overline{m} + \frac{s^2}{2}\right)\right](x_{t-1} - y_{t-1}) + s\sqrt{\frac{1}{j}(x_{t-1} - y_{t-1})}\ e_t \tag{9}$$

where ε_t represents a draw from a standard normal distribution, and y_j is the annuity payout at period *j*. The inflation process is specified analogously. Each of the reported experiments is based on 1 000 draws from a standard normal distribution.

5.2 Parameter values

The simulations reported here are based on an annuity purchase made by a 65 year old man after 35 years of earnings. The individual earnings path is assumed to be constant relative to the economy-wide average. He is assumed to contribute 10 per cent of wages to a defined contribution pension fund, which earns four per cent a year in real terms after administrative charges. Real wage growth is assumed to be three per cent. At retirement, average earnings are set at $40 000. These assumptions lead to an accumulation of $160 946 for a person on average earnings. We also look at workers with half and one-and-a-half times average pay, whose retirement accumulations vary proportionally from the average-earnings case. This shows the differential effect of the public pension scheme on both individual incomes and on the public finances.

Table 3. **Parameter values used in numerical simulations**

Accumulation stage			
Average earnings at retirement (age 65)	$40 000		
Real wage growth	3%		
Real rate of return	4%		
Years of contributions	35		
Contribution rate	10%		
Total accumulation	$160 946		
Payout stage			
Annuity escalation	3%		
Public pension guarantee, proportion of average earnings	10%	20%	
Real rate of return on risky assets	5%		
Real rate of return on safe assets	3%		
Administrative charges	1%		
Inflation, expected rate	5%	15%	25%
Inflation, standard deviation	0.05	0.15	0.25

Note: public pension guarantee set at $4000 and $8000 indexed to wage growth

For the payout phase, we have assumed a real safe rate of return of two per cent after administration costs. There is a premium of two percentage points for retirement instruments based upon risky portfolios (standard deviation set at 20 per cent). The inflation rate is expected to be 15 per cent in the central case, with a standard deviation also of 15 per cent. Real wage growth continues at three per cent.

Table 3 sets out the parameters. We adopt as a benchmark case a man on average earnings with a public pension guarantee of 20 per cent of average earnings. We also investigate the case of a lower pension minimum: 10 per cent of average earnings. The first pillar is withdrawn dollar-for-dollar with annuity payments, and there is no separate guarantee of benefits from the DC scheme.

Mortality is specified using Australian population survival probabilities, which are compiled by the Australian Government Actuary every five years. For this analysis we use the 1990-92 life tables, modified to reflect the projected cohort mortality improvements that a 65-year-old purchasing an annuity now might experience over time.

6. Results

One approach to assessing effective annuity products involves comparing their payout structures at different points in time. Simple payout comparison of the three most widely encountered annuity types are graphed for the benchmark case in Chart 2*a*. Charts 2*b* and 2*c* depict income flows including a public pension minimum of 20 and 10 per cent of average pay respectively.

The erosion of real purchasing power of the nominal annuity in a high inflation environment is dramatically demonstrated. By contrast, the CPI-indexed annuity maintains its purchasing power. The phased withdrawal offers moderate support in the early years, with exhaustion of resources after about 15 years. The income flow from this latter product is lower than the nominal annuity because of the absence of longevity risk sharing: bequests, intended or otherwise, are left by holders of allocated annuities who die before the balance is exhausted.

Chart 2*a*. **Expected real annuity income by annuity type: purchase price $160 946**

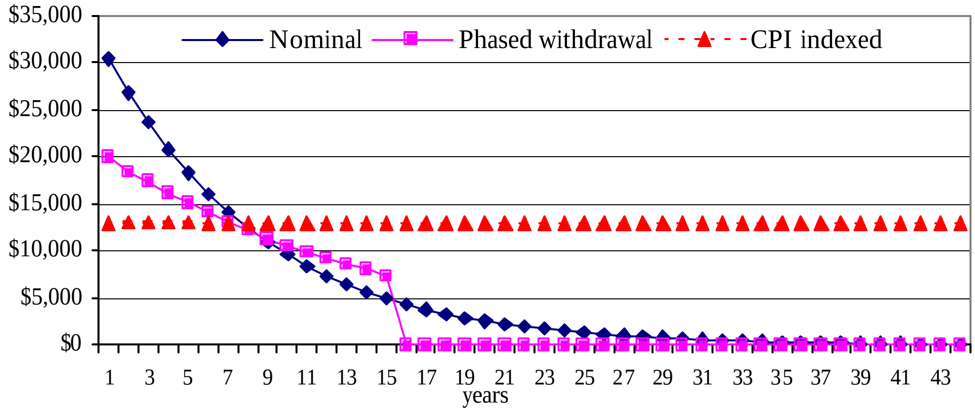


Chart 2*b*. **Expected real total income by annuity type: purchase price $160 946, first pillar of 20 per cent of average earnings**

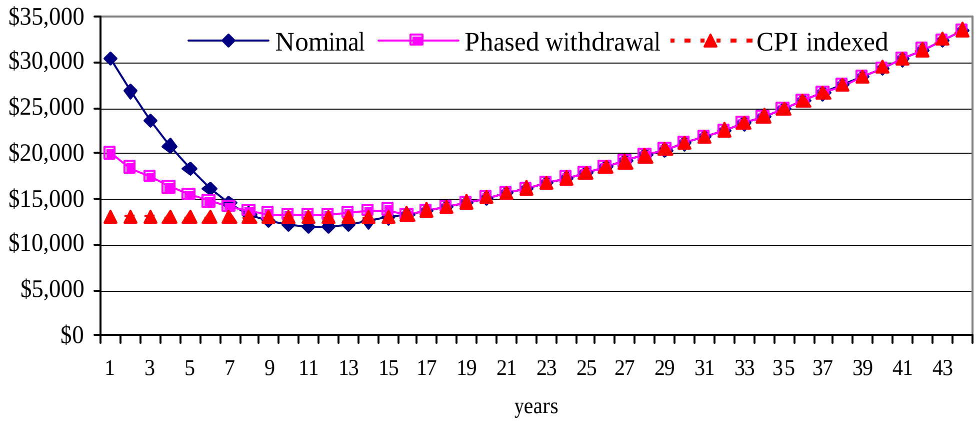


Chart 2*c*. **Expected real total income by annuity type: purchase price $160 946, first pillar of 10 per cent of average earnings**

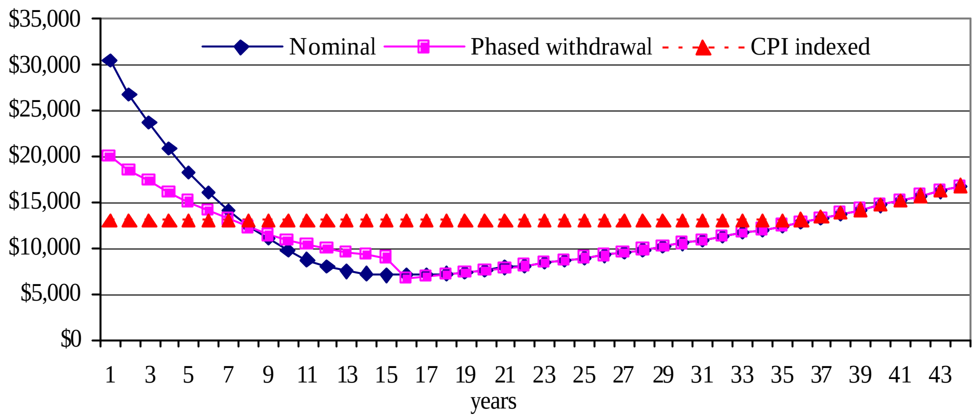


Chart 2*b* illustrates the importance of an underlying public pension guarantee indexed to wages. Within a dozen years, the benchmark retiree has come to rely on the first pillar, regardless of the annuity purchased. Investment risk associated with the phased withdrawal enjoys downside protection from the public pension guarantee. Thus, the real value of the total income for people holding this product is greater than the average phased withdrawal income alone, resulting in an average which lies above the threshold for the public scheme. Through a similar mechanism, inflation risk results in the value of total income associated with the nominal annuity lying above the first pillar threshold.

Chart 2*c*, illustrates the effect of the maintenance of the real value of the CPI-indexed annuity on public pension payouts. With a public scheme guaranteeing 10 per cent of average earnings, the public pension is not paid until 35 years after retirement, at which point mortality will have dramatically reduced the public sector's obligations.

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 towards 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 payments (the first pillar) 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:

$$U_t(c_t) = \frac{1}{1-g}\left(c_t^{1-g} - 1\right) \qquad (\gamma \geq 0;\ \gamma \neq 1) \tag{10a}$$

$$U_t(c_t) = \ln(c_t) \qquad (\gamma = 1) \tag{10b}$$

and

$$c_t = \frac{y_t}{(1+\pi)^t} \tag{11}$$

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.[21] Utilities are discounted for survival probability and time, and period-by-period utilities are aggregated to give an overall rest-of-lifetime score:

$$V = \sum_{t=1}^{w} U_{t} \cdot {}_t p_x / (1 + r)^t \tag{12}$$

where ρ is the discount rate, set at 3.5 per cent to reflect morbidity as well as pure time preference.

The present value of revenue outlays are calculated in each case according to:

$$PV(T) = \sum_{t=1}^{w} \frac{T_t / (1+p)^{(t-1)}}{(1+r)^t} \tag{13}$$

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 is the value of this parameter, the more risk averse the individual's preferences. The empirical literature offers only limited guidance on the likely value of γ. 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 (1999) estimate γ at about 0.5, and Shea (1995) reports estimates for high-income individuals that vary from 0.2 to 0.4. By contrast, macroeconomic models often estimate much higher values of γ. We evaluate preference rankings for our menu of annuity products for values of γ ranging from 0.5 to 2.5.

In what follows, we assume a 65-year-old man is retiring in 1999, having accumulated a retirement benefit throughout his working life. For simplicity, we focus on three income levels (represented by different purchase prices). We use average male life expectancy, since this is consistent with the assumption of mandatory annuity purchase. The possibility of reversion of the annuity to a spouse is ignored. The analysis is conducted in a policy environment that guarantees means-tested safety-net support (the

21 Technically, the coefficient of relative risk aversion.

first pillar) and mandatory private second pillar accumulations. Further, we ignore taxation and government benefit provisions that specifically favour one annuity type over another.

Table 4 reports rankings for our menu of annuity products for values of risk aversion, γ, ranging from 0.5 to 2.5. 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 nominal life annuity scores well, across a range of risk-aversion parameters and income levels. Longevity risk spreading is important here, as is the reduction of purchasing power over time, a pattern consistent with the discount rate used. Associated first-pillar pension payouts are in the middle of the reported range across annuity types.

The variable annuity, however, delivers these same features, with a somewhat higher rate of return. For those who rely heavily on the first pillar, this is the preferred product, since the pension effectively provides them with downside protection. However, this is expensive for governments.

The term annuity, a life-expectancy product, is ranked below the nominal and variable annuities, even though it is consistently the most expensive for government. This low ranking 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. However, 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 (naturally) dislike. No matter how preference toward risk is specified, this product has unattractive features. The phased withdrawal performs poorly for similar reasons: in this case, variable consumption flows are followed by a long period of uniform consumption, indexed to real wages.

In addition, life expectancy products are undervalued in this approach to preference ranking. In both cases, death prior to life expectancy results in a bequest. The utility function specified in equation 10 has no bequest argument, and the value of the bequest is therefore not reflected in the preference ranking.

Table 4. **Individual preference rankings across annuity types by income and risk aversion range**

4a. Average earnings

	1st year income $	Utility rankings, by coefficient of risk aversion 0.5	1.5	2.5	Present value of public pension payouts $
Nominal annuity	30 445	2	1	1	37 267
CPI indexed annuity	13 014	5	5	5	4 525
Phased withdrawal	20 002	4	4	4	42 481
Variable annuity	33 472	1	2	2	44 133
Term annuity	27 292	3	3	3	44 420

Note: present value of bequests: term annuity, $82 651 and phased withdrawal, $116 542

4b. 50% of average earnings

	1st year income $	Utility rankings, by coefficient of risk aversion 0.5	1.5	2.5	Present value of public pension payouts $
Nominal annuity	15 222	2	2	2	56 190
CPI indexed annuity	8 100	5	5	5	47 533
Phased withdrawal	10 112	4	4	4	61 671
Variable annuity	16 743	1	1	1	61 494
Term annuity	13 646	3	3	3	61 847

Note: present value of bequests: term annuity, $41 326 and phased withdrawal, $58 271

4c. 150% of average earnings

	1st year income $	Utility rankings, by coefficient of risk aversion 0.5	1.5	2.5	Present value of public pension payouts $
Nominal annuity	45 666	1	1	2	28 321
CPI indexed annuity	19 521	5	3	1	260
Phased withdrawal	30 003	4	5	5	35 633
Variable annuity	50 208	2	2	4	35 475
Term annuity	40 938	3	4	3	37 208

Note: present value of bequests: term annuity, $123 978 and phased withdrawal, $174 813

Perhaps most surprising is the poor performance of CPI-indexed life annuity. In an environment with high and volatile inflation, annuities offering inflation protection might have been expected to be a favoured product. But the volatility of inflation is so large and the nominal interest rate, on which the first year payouts of other products are based, so high, that the real payout streams are relatively heavily backloaded. As a result, the early-year payouts are less than half those offered under nominally based contracts. Even more important, while early-year CPI-indexed payouts are low, for the average earnings case, they are still high enough to avoid any reliance on first-pillar support, and indexation denies the annuitant first-pillar payouts in later years. The present value of public pension payouts for

CPI-indexed annuities is much lower than for any other product, for all levels of income. Only for risk-averse high-income earners, therefore, is the CPI-indexed product an attractive alternative.

Table 5 reports replacement rates for annuity and total income for each annuity type, and for a public pension minimum of both 10 per cent and 20 per cent of average earnings. The simple replacement rate calculated by expressing income in the first year of retirement as a proportion of income in the last year of working life is reported in the top panel. Because nominal annuities are front-loaded, there are no first-pillar payouts in the first year of retirement, and annuity and total replacement rates are equal.

Table 5. **Replacement rates on three measures for alternative annuity types and first pillar levels**

Income	*Public pension*	*Nominal annuity*	*CPI-indexed annuity*	*Phased withdrawal*	*Variable annuity*	*Term annuity*
1st year payout/ final wage						
Total	10%/20%	70	30	46	77	63
PV of pension/ PV of wage						
Annuity		28	25	23	28	24
Total	10%	30	25	25	31	27
Total	20%	34	26	30	36	32
PV of pension/ PV of final wage (indexed to prices)						
Annuity		37	33	29	37	32
Total	10%	39	33	33	40	36
Total	20%	45	34	39	46	42

This simple replacement rate calculation is misleading as an indicator of retirement income support, however. It is more meaningful to compare present values of retirement income streams with the present values of non-retirement streams. The central panel therefore expresses replacement rates as a proportion of the present value of wages, giving an estimate reflecting community standards of living. It also gives replacement rates relative to the present value of a stream of payments offering 100 per cent of earnings at retirement, indexed to prices.

The simple replacement-rate calculation presents the CPI-indexed annuity as an unattractive product, with replacement at less than half that offered by a nominal annuity. The variable annuity offers the best first-year payout. In between lie the other annuity types. Perhaps the most striking aspect of this column is the range of replacement rates reported.

The alternative measures of replacement rate report far less difference across annuity types. The variable annuity offers the best replacement rate, consistent with its riskiness: it offers no protection against either investment or inflation risk. The CPI-indexed annuity still generates the lowest aggregate replacement rate in the annuity series, consistent again with the very complete insurance against longevity, investment and inflation risk that it offers.

Table 6 reports the simple replacement rates calculated for both nominal and CPI-indexed life annuities for a range of inflation rates, from five per cent to 25 per cent. The standard deviation of inflation is assumed to increase proportionately with the underlying inflation rate.

Two important patterns emerge from Table 6. First, as in Table 4, nominal annuities provide higher early retirement replacement rates than CPI-indexed annuities. But, because the rate at which they lose their real value increases with the inflation rate, the present value of government obligations under any first pillar increases with inflation as well. If the public scheme guarantees a payment of 20 per cent of average wages, then the present value of public pension obligations for our benchmark retiree is $37 267. But, with inflation at 25 per cent, this figure increases to more than $51 137. By contrast, CPI-indexed annuities in a corresponding scenario imply much smaller public pension obligations.

Second, the volatility of the present value of public pension payouts is much greater for nominal than for CPI-indexed annuities. For a retiree who earned half average wages, a public pension guarantee of 20 per cent of average wages generates a standard deviation of the present value of public obligations of 5 116 for a nominal annuity. This is more than 20 times the value for a nominal annuity, given 5 per cent expected inflation. If expected inflation is 25 per cent, volatilities for both annuity types are much higher, but the ratio of nominal to CPI-indexed volatility is much less.

Table 6. **Annuity and total replacement rates at alternative inflation rates and with proportional inflation volatility**

Earnings/ average	Public pension/ average earnings	Annuity	Price inflation, volatility = 5%				Price inflation, volatility = 15%				Price inflation, volatility = 25%			
			Annuity	Total	PV public pension	sd of PV	Annuity	Total	PV public pension	sd of PV	Annuity	Total	PV public pension	sd of PV
100%	10%	Nominal	44.8	44.8	1954	1115	69.7	69.7	11452	4588	91.1	91.1	19280	6396
		Indexed	31.1	31.1	2	0	29.8	29.8	6.6	2	28.8	28.8	15	5
	20%	Nominal	44.8	44.8	16586	5116	69.7	69.7	37267	10950	91.1	91.1	51137	13477
		Indexed	31.1	31.1	3703	173	29.8	29.8	4525	590	28.8	28.8	5323	1078
50%	10%	Nominal	44.8	44.8	8293	2558	69.7	69.7	18633	5475	91.1	91.1	25569	6738
		Indexed	31.1	31.1	1852	86	29.8	29.8	2262	295	28.8	28.8	2662	539
	20%	Nominal	44.8	44.8	45269	6408	69.7	69.7	56190	11231	91.1	91.1	65803	13049
		Indexed	31.1	39.2	46334	618	29.8	37.1	47533	2196	28.8	35.2	48397	4120
150%	10%	Nominal	44.8	44.8	651	511	69.7	69.7	8248	3933	91.1	91.1	16093	6018
		Indexed	31.1	31.1	0	0	29.8	29.8	0	0	28.8	28.8	0	0
	20%	Nominal	44.8	44.8	7577	3383	69.7	69.7	28321	10019.2	91.1	91.1	43526	13198
		Indexed	31.1	31.1	149	12	29.8	29.8	260	51	28.8	28.8	408	118

Note: indexed annuities are linked to the CPI. PV = present value; sd = standard deviation

Table 7. **Annuity and total replacement rates with alternative inflation volatility and inflation of 15 per cent**

Earnings/ average	Public pension/ average earnings	Annuity	Inflation volatility = 5%				Inflation volatility = 15%				Inflation volatility = 25%			
			Annuity	Total	PV public pension	sd of PV	Annuity	Total	PV public pension	sd of PV	Annuity	Total	PV public pension	sd of PV
100%	10%	Nominal	69.6	69.6	11081	1618	69.7	69.7	11452	4588	70.0	70.0	12087	7055
		Indexed	30.2	30.2	5	0	29.8	29.8	7	2	28.8	28.8	13	6
	20%	Nominal	69.6	69.6	37171	3814	69.7	69.7	37267	10950	70.0	70.0	37675	16701
		Indexed	30.2	30.2	4124	84	29.8	29.8	4525	590	28.8	28.8	5657	1521
50%	10%	Nominal	69.6	69.6	18586	1907	69.7	69.7	18634	5475	70.0	70.0	18838	8351
		Indexed	30.2	30.2	2062	42	29.8	29.8	2263	295	28.8	28.8	2828	760
	20%	Nominal	69.6	69.6	56945	3822	69.7	69.7	56190	11231	70.0	70.0	55180	17810
		Indexed	30.2	37.1	46541	263	29.8	37.1	47533	2196	28.8	37.1	49720	5905
150%	10%	Nominal	69.6	69.6	7777	1371	69.7	69.7	8248	3933	70.0	70.0	9032	6115
		Indexed	30.2	30.2	0	0	29.8	29.8	0	0	28.8	28.8	0	0
	20%	Nominal	69.6	69.6	27815	3536	69.7	69.7	28321	10019	70.0	70.0	29276	15324
		Indexed	30.2	30.2	217	8	29.8	29.8	260	51	28.8	28.8	403	148.

Note: indexed annuities are linked to the CPI. PV = present value; sd = standard deviation

The results of Table 6 are drawn from simulations in which the inflation rate and inflation volatility move together. In Table 7, we examine the effect of inflation volatility alone. For a set expected inflation rate of 15 per cent, we compare simulations in which inflation volatility varies from 0.05 to 0.25.

As for Table 6, the volatility of the present value of public pension payouts increases with inflation volatility, even when expected inflation is held constant. However, increasing volatility alone has very limited impact on the expected present value of public pension payouts.

7. Concluding remarks: retirement-income policy formulation

This paper has sought to shed light on the design of income streams in countries that have adopted systems of mandatory, privately managed retirement accumulation. Practice has varied widely across these nations, with some permitting a range of withdrawals, while others insist on indexed life annuities. Policy formulation so far appears to have been largely driven by what has been in place before the adoption of mandatory accumulations.

If retirement income streams are mandated, questions about the nature and characteristics of the instruments that satisfy such a requirement remain. Minimum annuity design criteria deemed to satisfy the mandating requirement must be developed, and should aim to trade off the financial risks faced by retirees, including replacement rate risk.

We have focused on differences in the payout profiles promised by different annuity types. These may be very significant for individual welfare, and are also significant for policy. Whether a retiree will be entitled to first-pillar payments, and in what degree, will be determined by the means test specifications of the first pillar, and the second-pillar payout pattern. It is easy to construct examples in which expected first-pillar outlays will be lower for, say, a phased withdrawal than for a fully indexed life annuity. Government spending on welfare payments to the elderly will not necessarily be minimised by mandating the purchase of a full insurance annuity.

The results suggest that the nominal and variable annuities rank highest in terms of utility from the perspective of the individual, regardless of income level, risk aversion or the level of public pension guarantee. These two annuities offer the highest first year payouts and the highest replacement rates. For low-income earners in particular, variable annuities are attractive since the public pension provides downside income protection.

Phased withdrawals score poorly. There are two reasons for this. First, over the full retirement period, they yield an income stream, which in early years is subject to investment risk and in later years — when fully reliant on the public pension — yield a completely safe income stream. Second, phased withdrawals do not permit longevity risk spreading.

For the government, the CPI-indexed annuity is least costly. This is demonstrated for a range of inflation levels and volatilities, and across a range of income and first pillar support levels.

Private provision of indexed annuities in developing countries will depend critically on the availability of safe CPI-indexed bonds of long duration. Bonds of this type have been available for many years in both Australia and the United Kingdom. The immunisation that this offers annuity issuers has permitted the development of significant markets for indexed annuities in both countries. By contrast, indexed annuities represent only a small proportion of the United States annuity market, where indexed government bonds have been issued only in the last three years.

While providing an overview of the regulatory controls which might be required in developing a deep and active annuity market, this paper has not considered annuity regulation in detail. Issues such as the annuitisation of small accumulations, the possibility of public coverage of systemic longevity risk, and the possible development of tapered means testing for first-pillar support remain topics for future research.

8. References

Asher, M. (1998), 'Investment policy and performance of provident funds in South-East Asia', *mimeo.*, National University of Singapore.

Barrientos, A. (1998), *Pension Reform in Latin America*, Ashgate, Aldershot.

Bateman, H. (1997), *Three Essays on the Economics of Mandatory Private Retirement Saving*, PhD Thesis, University of New South Wales.

— and Piggott, J. (1997), 'Mandatory retirement saving: Australia and Malaysia compared', in Valdes-Prieto, S. (ed), *The Economics of Pensions: Principles, Policies, and International Experience*, Cambridge University Press.

— and — (1999), 'Mandatory retirement saving policy: the Australian experience', *Geneva Papers on Risk and Insurance: Issues and Practice*, vol. 24, no. 1, January 1999, pp. 95-113

Blommenstein, H.J. (1998), 'Ageing-induced capital flows to emerging markets do not solve the OECD's basic pension problem', in Blommenstein, H.J. and Funke, N. (eds), *Institutional Investors in the New Financial Landscape*, OECD, Paris.

Boskin, M., Kotlikoff, L. and Shoven, J. (1988), 'Personal security accounts: a proposal for fundamental social security reform', in Wachter, S. (ed.), *Social Security and Private Pensions: Providing for Retirement in the Twenty-First Century*, Lexington.

Brugiavini, A. (1993), 'Uncertainty resolution and the timing of individual annuity purchases', *Journal of Public Economics*, vol. 50, January, pp. 31-62.

Chlon, A. (2000), 'Public information and pension reform in Poland', Pension Reform Primer series, Social Protection Discussion Paper no. 0019, World Bank, Washington, D.C.

Crosby, M. (1998), 'Stock returns and inflation', *mimeo*, Department of Economics, University of Melbourne.

Davis, E.P. (1995), *Pension Funds: Retirement Income Security and Capital Markets: An International Perspective*, Clarendon Press, Oxford.

Demarco, G., Rofman, R. and Whitehouse, E.R. (1998), 'Supervising mandatory pension funds: issues and challenges', Pension Reform Primer series, Social Protection Discussion Paper no. 9817, World Bank, Washington, D.C.

Demirguç-Kunt, A. and Schwarz, A. (1999), 'Taking stock of pension reforms around the world', Pension Reform Primer series, Social Protection Discussion Paper no. 9917, World Bank, Washington, D.C.

Disney, R.F. (1999*a*), 'OECD pension systems in crisis: what are the reform options?' Pension Reform Primer series, Social Protection Discussion Paper no. 9921, World Bank, Washington, D.C.

— (1999*b*), 'Notional accounts as a pension reform strategy: an evaluation', Pension Reform Primer series, Social Protection Discussion Paper no. 9928, World Bank, Washington, D.C.

Ely, D.P. and Robinson, K.J. (1989), 'The stock market and inflation: a synthesis of the theory and evidence', *Federal Reserve Bank of Dallas Economic Review*, March, pp. 17-29.

Feldstein, M. (ed) (1998), *Privatizing Social Security*, University of Chicago Press for National Bureau of Economic Research.

Finkelstein, A. and Poterba, J.M. (1999), 'Selection effects in the market for individual annuities: new evidence for the United Kingdom', Working Paper no. 7168, National Bureau of Economic Research, Cambridge, Mass.

Formica, A. and Kingston, G. (1991), 'Inflation insurance for Australian annuitants', *Australian Journal of Management*, vol. 16, no. 2, December, pp. 145-64.

Gourinchas, P. and Parker, J. (1999), 'Consumption over the lifecycle', Working Paper no. 7271, National Bureau of Economic Research, Cambridge, Mass.

Hannah, L. (1986), *Inventing Retirement: The Development of Occupational Pensions in Britain*, Cambridge University Press.

Hepp, S. (1990), *The Swiss Pension Funds: An Emerging New Investment Force*, Paul-Haupt, Bern.

Holzmann, R. (1998), 'A World Bank perspective on pension reform', Pension Reform Primer series, Social Protection Discussion Paper no. 9807, World Bank, Washington, D.C. (a version was also published in *International Social Security Review*, vol. 53, no. 1, pp. 11-36, 2000).

— (2000), 'Can investment in emerging markets help to solve the aging problem?' Social Protection Discussion Paper no. 0010, World Bank, Washington, D.C.

—, Packard, T. and Cuesta, J. (2000), 'Extending coverage in multi-pillar pension systems constraints and hypotheses, preliminary evidence and future research agenda', Social Protection Discussion Paper no. 0002, World Bank, Washington, D.C.

Iyer, S.N. (1993), 'Pension reform in developing countries', *International Labour Review*, vol. 132, no. 2, pp. 187-207.

James, E. (1999), 'Coverage under old age security systems and protection for the uninsured: what are the issues?' paper presented at the conference 'New Ideas on Old-Age Security', World Bank, Washington, D.C., September.

— and Vittas, D. (1999), 'Annuity markets in comparative perspective', presented to the conference 'New ideas about old-age security', World Bank, Washington, D.C., 14-15 September.

Kane, C. and Palacios, R.J. (1997), 'Reporting the implicit pension debt', *Finance and Development*.

McHale, J. (1999), 'The risk of social security benefit rule changes: some international evidence', Working Paper no. 7031, National Bureau of Economic Research, Cambridge, Mass.

Merton, R.C. (1992), 'Financial innovation and economic performance', *Journal of Applied Corporate Finance*, vol. 4, Winter, pp. 87-109.

— and Bodie Z. (1995), 'Financial infrastructure and public policy — a functional perspective', in Crane, D. *et al.* (eds), *The Global Financial System — A Functional Perspective*, Harvard Business School Press.

Mitchell O.S. (1998), ‘Building an environment for pension reform in developing countries’, Pension Reform Primer series, Social Protection Discussion Paper no. 9803, World Bank, Washington, D.C.

—, Poterba, J. M. and Warshawsky, M. J. (1999), ‘New evidence on the money’s worth of individual annuities’, *American Economic Review*, vol. 89, no. 5, pp. 1299-1318.

Musalem, A. and Catalan, M. (1999), ‘Contractual savings and capital market development: an analysis of OECD countries’, Pension Reform Primer series, Social Protection Discussion Paper, World Bank, Washington, D.C., forthcoming.

Outreville, J.F. (1996), ‘Life insurance markets in developing countries’, *Journal of Risk and Insurance*, vol. 63, no. 2, pp. 263-278.

Palacios, R.J. and Rofman, R. (2000), ‘Annuity markets and benefit design in multipillar pension schemes: Experience and lessons from four Latin American countries’, Pension Reform Primer series, World Bank, Washington, D.C.

Palacios, R.J. and Pallares-Miralles, M. (2000), ‘International patterns of pension provision’, Pension Reform Primer series, Social Protection Discussion Paper no. 0009, World Bank, Washington, D.C.

Queisser, M. (1998), ‘The second generation pension reforms in Latin America’, Ageing Working Paper no. 5.4, OECD, Paris.

Rofman, R. and Demarco, G. (1999), ‘Collecting and transferring contributions in multipillar pension schemes’, Pension Reform Primer series, Social Protection Discussion Paper no. 9907, World Bank, Washington, D.C.

Roseveare, D., Leibfritz, W., Fore, D. and Wurzel, E. (1996), ‘Ageing populations, pension systems and government budgets: simulations from 20 countries’, Working Paper no. 168, Economics Department, OECD, Paris.

Samuelson, P.A. (1987), ‘Comment’, in Bodie, Z. and Shoven, J. (eds), *Financial Aspects of the United States Pension System*, University of Chicago Press.

Schieber, S.J., Dunn. R and Wray, D.L. (1998), ‘The future of the defined contribution revolution’, in Mitchell, O.S. and Schieber, S.J. (eds), *Living with Defined Contribution Pensions: Remaking Responsibility for Retirement*, University of Pennsylvania Press, Philadelphia, Penn.

Shea, J. (1995), ‘Union contracts and the life-cycle/permanent-income hypothesis’, *American Economic Review*, vol. 85, no. 1, pp. 186-200.

Srinivas, P.S., Whitehouse, E.R. and Yermo, J. (2000), ‘Regulating private pension funds’ structure, performance and investments: cross-country evidence’, Pension Reform Primer series, Social Protection Discussion Paper, World Bank, Washington, D.C., forthcoming.

Stanton, D. and Whiteford, P. (1998), ‘Pension systems and policy in the APEC economies, volume 2: Pension Systems and Policy’, Discussion Paper, Asian Development Bank, Manila.

Stock, J. and Wise, D. (1990), ‘Pensions, the option value of work and retirement’, *Econometrica*, vol. 58, no. 5, September, pp. 1151-1180.

United Kingdom, Department of Social Security (2000), 'Defined contribution pension schemes: indexation: a consultation document', London.

Valdés-Prieto, S. (1998), 'Risk in pensions and annuities: efficient designs', Pension Reform Primer series, Social Protection Discussion Paper no. 9804, World Bank, Washington, D.C.

Vittas, D. (1999), 'Pension reform and financial markets', Development Discussion Paper no. 697, Harvard Institute for International Development, Cambridge, Mass.

Walliser, J. (2000), 'Regulating withdrawals from mandatory funded pension accounts', Pension Reform Primer series, Social Protection Discussion Paper no. 0008, World Bank, Washington, D.C.

Whitehouse, E.R. (2000), 'Consumer financial literacy, public information and pension reform: a case study of the United Kingdom', Pension Reform Primer series, Social Protection Discussion Paper no. 0004, World Bank, Washington, D.C.

World Bank (2000*a*), 'Initial conditions: building an environment for pension reform', Pension Reform Primer briefing, Washington, D.C.

— (2000*b*), 'Annuities: regulating withdrawals from individual pension accounts', Pension Reform Primer briefing, Washington, D.C.