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Annuity Values in Defined Contribution Retirement Systems:
Australia and Singapore Compared

Throughout much of the developed world, retirement schemes have been developed to provide a degree of protection against old-age risk. For example, in some countries public defined benefit (DB) plans pay retirement benefits that protect the aged against outliving their resources due to longer than expected life and/or financial misfortune. Corporate DB plans also are typically configured to pay out a guaranteed retirement income stream linked to working life earnings and continuing until death (McGill *et al.* 2004). More recently, a rather different pattern of risk-bearing is taking shape as countries move toward defined contribution (DC) retirement systems. Either publicly-mandated or voluntarily provided, the DC model is accumulation-based, characterized by specifying the contribution that must be made to the plan, usually as a fraction of employee earnings.

The DC model is very popular in Australia as well as in various Asian countries, most notably Singapore, where it offers an accumulation structure with mandatory contributions to individual accounts. DC plans have been powerful engines for channelling workers' earnings into retirement saving (Palacios and Pallares-Miralles, 2000). But despite their popularity, there has been little attention devoted to how these plans function during the *decumulation* phase. The specific problem confronting DC participants is that retirement asset accumulations must be managed carefully beyond the retirement date all the way to death, so as to ensure a dependable flow of income in retirement (Bodie 1990).

Economic studies have previously demonstrated that products such as life annuities can play a key role in the decumulation process, working to ensure a degree of consumption smoothing and longevity insurance.[1] Despite the theoretical attractiveness of annuities, evidence from the US and the UK shows that few people hold annuities in their retirement portfolios and voluntary annuity markets remain thin. Part of the reason may be that life annuity prices appear high relative to population life expectancy and to alternative investment returns, though of late, prices have been dropping steadily (Brown *et al.* 2000). In other countries little is known about annuity market performance; this is the subject of our analysis. Specifically we compute and assess the money's worth of individual annuities offered in Singapore and Australia. Both countries rely on a mandatory DC-type plan as their primary

[1] See for instance Friedman and Warshawsky (1988, 1990), Warshawsky (1988), and Mitchell et al. (1999).

employment-linked compulsory retirement vehicle, but the two countries have sharply contrasting annuity markets and old-age support systems. After laying out the assumptions and methods used to calculate money's worth of life annuities, we discuss findings. The paper concludes with a discussion of the potential relevance of our results for other countries.

The Retirement Framework in Singapore and Australia

Singapore and Australia were deliberately chosen for this study because both rely on mandated contributions to national DC systems, rather than on pay-as-you-go taxes to finance an employment-related retirement benefit program. In Singapore, the Central Provident Fund (CPF) operates as a centrally-administered publicly-mandated retirement scheme built around individual accounts. Both employees and employers must contribute a substantial fraction of earnings until the employee attains age 55. The current contribution rate is set at 32 per cent, split between employers and employees, though the rate was 40 per cent until the Asian crisis.[2] A proportion of contributions is channeled to provide a buffer to cover participant healthcare expenses, and they may also be used for the (heavily subsidized) purchase of residential property. They may sometimes be used for small business investment and education. Other than the CPF, the Central Government provides limited financial support for the aged. Fewer than 2 per cent of the elderly receive social assistance from the government, and strong emphasis is placed on family provision for the elderly. In addition, labour force participation among the elderly is high by developed-economy standards.[3]

In Australia, by contrast, a relatively generous and means-tested social safety net insulates the elderly from destitution.[4] By law, the minimum-income safety net is targeted so the monthly indexed pension for life amounts to 26 per cent of average male full-time earnings for a single pensioner and 43 per cent for a couple. This social insurance payment, along with owner-occupied housing paid for over workers' lifetimes, comprise the key retirement assets for most elderly Australians today. The age pension benefit is means-tested against both private income and assets, but the thresholds are set relatively high: over half the aged in Australia currently receive a full government old-age benefit, and 80 per cent receive some payment from this safety net program.

In addition to the safety-net benefit, Australia has mandated a privately-managed defined

[2] It is anticipated that the contribution rate will return to the 40 per cent level in the future.
[3] For a more detailed discussion on the Singaporean pension system see www.cpf.gov.sg, Asher (1999), and McCarthy et al (2002).
[4] For more on the Australian retirement system see Bateman, Kingston and Piggott (2001)

contribution system termed the "Superannuation Guarantee" system. Under these rules, employers must pay at least 9 per cent of earnings to a pension plan, with the plan manager normally selected by the employer. Some employees have the opportunity to select their investment portfolios, subject to offerings.[5] The retirement accumulation is required to be "preserved" – that is, not used by the worker for virtually any reason – until the age of 55. (This latter age is being increased to 60 over time). Thus far, accumulations have been well-insulated against non-retirement uses (e.g. housing or education).

Retirement Payouts in Singapore

The Singaporean CPF design has a mandatory contribution rate of up to 40 per cent of payroll, a level that might lead one to conclude that Singaporean workers would reach retirement age having accumulated large holdings in their DC portfolios. This turns out not be the case, however, since the accumulation need not be preserved in the fund to retirement age. In fact, the bulk of the funds is actually used for investment in housing. Consequently retirement accumulations in the CPF financial portfolio are generally low at retirement age (McCarthy et al, 2002).

This outcome prompted a policy change in the early 1990s, when retirees were required to have a "minimum sum" at retirement – one that must be accumulated by age 55. This minimum sum is a lower-bound financial asset target that must now be preserved for a further 7 years until age 62. The minimum sum was set at $Sg 65,000 in the year 2000, rising to $Sg 80,000 by the year 2003.[6] Currently only a minority of retirees has accumulated enough assets to meet the minimum sum requirement by age 55 in financial assets, with most having to "pledge their dwelling equity" to make up the shortfall. The key here is that pension accumulations up to the minimum sum cannot be taken as a lump sum at retirement. Rather, when the funds become accessible at age 62, they must either be left in the CPF to earn interest, be deposited in an approved bank for gradual and regulated drawdown, or be used to purchase a life annuity.

The effect of this CPF regulatory evolution has been to boost the size of the annuity market in Singapore substantially. Table 1 indicates the number of annuities sold each year over the last decade. Except for a decline during the Asian crisis, annuity sales have shown a steady increase over this period. In 1999, for instance, about one-sixth of the retiring workforce

[5] Legislative initiatives are pending to free up this restriction.
[6] Throughout, domestic currencies are used for dollar values. At July 2000, $US 1 = $Aus 1.76; $US 1 = $Sg 1.8.

purchased an annuity, a rather large ratio compared to other countries. This represented the sale of 3,200 annuities for an aggregate premium value of $Sg 173 million, out of about 22,000 new retirees that year. Their average monthly payout in 1999 was $Sg 555 for males and $Sg 519 for females (Table 2).

Tables 1 and 2 here

There are several annuity issuers in Singapore offering products that differ in detail but are similar in broad structure. The preservation requirement means that all annuities offered are deferred for 7 years; after that, they typically have a guarantee period or repayment sum, which extends for some other number of years. Some annuities are offered with escalation of 1 or 2 per cent a year or with a discretionary profits add-on. One frequently-offered option is to purchase a nominal life annuity with a 7-year deferral period and also a further 15-year guarantee period. This is equivalent to purchasing a 15-year term annuity that is deferred for 7 years, along with a life annuity promising the same monthly payment deferred for 22 years. We have chosen this as our exemplar in the money's worth calculations reported below.

Retirement Payouts in Australia

Payouts from employer-sponsored pension (Superannuation) plans in Australia are relatively lightly regulated. Benefits may be taken as a lump sum up to generous limits, and about 75 per cent of payouts are currently in this form.[7] In contrast with Singapore, the Australian retirement income stream market is relatively small, comprising a diverse array of investment and retirement provision products. Available arrangements may be classified into three major product groupings: lifetime annuities, term-certain annuities, and phased withdrawals which are called "allocated annuities and pensions." Both life and term annuities have been available in the Australian market for many years, while the allocated products have only been on offer since late 1992.

Allocated products have characteristics quite different from other income stream products. First, there is no pooling of longevity risk, so it exposes participants to the chance that they could run out of money before death. Second, the investment risk of retirement capital is entirely borne by the annuitant, and as such he can choose from an array of investment options. Of the total funds under management in allocated products, 63 per cent are with managed funds, 23 per cent in capital stable and 14 per cent with the money market (Plan for Life Research, 2000b). These products can only be purchased with specific retirement saving

money, and the annual income drawdowns can vary between an upper and lower threshold. These characteristics have made allocated products very popular with Australian retirees, which is evident by the growth experienced since the early 1990s.[8]

Life and term annuities can of course protect purchasers against rate of return risk. That is, payouts may be fixed in nominal terms, indexed to inflation (the CPI), or escalated at a fixed rate. A guarantee period can be nominated at the time of purchase, where payments continue to be paid for a minimum period even if the annuitant dies during this time. These annuities can be bought with funds from any source. A term annuity may also be specified to pay back a percentage of the original capital on expiry of the contract — a residual capital value (RCV). Many of the short-term annuities specify an income of interest only and 100 per cent return of capital at the end of the contract, while many of the longer-term annuities specify an income comprising both interest and capital. Short-term annuities are the most popular form of immediate annuity offered in Australia, relative to genuine longevity and long-term annuities (life and life expectancy products).[9] As seen in Figure 1, the incentive structure implemented in 1998 designed to encourage longevity annuities has not resulted in a large swing towards these types of income stream products.[10]

Figure 1 here

Available market data suggest that very few people in the retiring population in Australia buy genuine longevity annuities at retirement. In 1999, of 33,001 immediate annuity policies sold (worth $A 2.75 billion), only 3,000 were life annuities and 10,000 term annuities with no RCV. Based on Australian Treasury data, this indicates that only 3 per cent of the estimated 100,000 Australians retiring each year purchased a life annuity.[11] The average monthly payout for a 65 year old, for a $100,000 purchase price, was $A666 for males and $A617 for females (see Table 3).

Calculating Annuity Money's Worth

An annuity promise represents a stream of income payments over a future period, with the payout duration a specified term or contingent on a specified event (e.g., an individual's

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[7] These payouts are frequently invested after being withdrawn, but no reliable data exist on their exact disposition.
[8] Since their introduction, funds under management have increased from around $Aust 3 billion to more than $Aust 25 billion in June 2000 (Plan for Life Research 2000b).
[9] Short-term annuities are an attractive and tax-preferred means of preserving superannuation accumulations between preservation age and actual retirement.

survival). In the simplest form of a life annuity, a purchaser typically pays a lump sum (or single premium) to an annuity provider in return for the promised stream of payments. In a competitive market, and ignoring commercial costs, the equivalence principle implies that the expected present discounted value (EPDV) of the benefit stream measured over the covered population should equal the original aggregate amount paid for the annuity. Simple equivalence is unlikely to hold in practice, of course, because there are costs that annuity providers have to cover including commissions, administration and marketing costs, reserves, and taxes.

The divergence between the initial premium and the EPDV of an annuity has been termed a "loading" by various authors including Friedman and Warshawsky (1988, 1990) and Mitchell *et al.* (1999). The EPDV of $1 in premium used to purchase an annuity is the money's worth of the annuity, and the difference between the initial $1 premium and the EPDV of the annuity represents the proportion of the premium that the annuitant is giving up in order to obtain longevity insurance.

When the EPDV is calculated with population mortality tables the loadings can be substantial. Ten years ago, for instance, voluntary private annuity markets in the US had total loadings on a nominal individual annuity worth almost 20 cents per dollar of premium for a 65 year old male, and 15 cents for a 65 year old female (Mitchell *et al.*, 2000). These loadings have come down substantially in recent years (Brown *et al.*, 2000). Such loadings reflect not only commercial costs but also adverse selection.

Annuity issuers use annuitant mortality tables to factor in the lighter mortality of voluntary annuity purchasers. The loadings on an annuity are smaller when valued using an annuitant mortality table, since on this calculation, the loading reflects only commercial costs. The difference between the EPDV of an annuity calculated using population versus annuitant mortality tables reflects the extent of adverse selection. The existence of adverse selection in the US voluntary annuity market is documented by Brown *et al.* (2000), Mitchell *et al.* (2000), and Friedman and Warshawsky (1988, 1990). To a limited extent, it is also present in the UK.[12] One consistent finding thus far is that in both the US and the UK, roughly half of the disparity

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[10] Longevity annuities meeting certain criteria are income and asset test exempt under eligibility criteria for the Age Pension.

[11] A life annuity can be purchased at any time by a retiree, not just at their initial retirement date. The retiree estimates are based on unpublished Treasury data on workers over 55 withdrawing from the labour force.

[12] See Finkelstein and Poterba (2002) and Murthi et al. (1999). James and Vittas (1999) explore related questions in other countries.

between the expected discounted value of the payouts and the policy premium appears to be due to adverse selection.

Defining Annuities Money's Worth Values

An annuity's money's worth is the ratio of the EPDV of annuity payments to the initial premium paid. The EPDV for a nominal annuity with a guarantee period is calculated according to:

$$\text{EPDV(nominal)} = \sum_{t=1}^{N\cdot 12} \frac{A_x}{(1+r_t)^t} + \sum_{t=(N\bullet 12)+1}^{(w-x)\cdot 12} \frac{A_x \cdot {}_t p_x}{(1+r_t)^t} \qquad (1)$$

where N is the guarantee period, x is the age at which the annuity is purchased, r_t is the riskless nominal interest rate at month t, w is the maximum life span, A_x is the (level) monthly annuity rate at the age of purchase, and ${}_t p_x$ is the probability that an individual age x will be alive after t months. The money's worth is then simply the EPDV divided by K, the premium required to purchase the annuity:

$$\text{MW} = \frac{\text{EPDV(nominal)}}{\text{K}} \qquad (2)$$

There are three important variable inputs to the EPDV calculation: the annuity market quote, the interest rate used to discount annual payments, and the mortality table used to determine how quickly to pay out the asset base over time. Data on the annual annuity payments and expected interest rates are drawn from market information, and for the purposes of money's worth calculations, are fairly straightforward to obtain.

Mortality estimates are more difficult to come by, and our approach requires some elaboration. To calculate the money's worth of market annuities and the extent of adverse selection, mortality estimates are needed for the general population and for annuitants.[13] These must be developed on a cohort basis and appropriately dated to match annuity pricing.[14] A cohort mortality table is generally constructed for each birth year representing the actual (or anticipated) mortality experience of that specific birth cohort. For example, if we need to project the expected longevity of a 55-year old Singaporean male in the year 2000, the 1945 birth cohort table would be appropriate. Cohort life tables take into account expected future

[13] These mortality assumptions are the cumulative probability of living t+x for an average person from the annuitant population (based on an annuitant population mortality data) and the cumulative probability of living t+x for an average person from the general population (derived from a general population mortality data).

[14] Thus annuity prices for 2000 should use life tables for that same year for money's worth valuations.

mortality improvements,[15] and thus they provide the basis for calculating how long a representative individual might be expected to live.

If the annuitant cohort mortality table relevant to a given market is available, it may be used to compute money's worth results. In practice, however, many countries have not collected enough data to derive annuitant cohort tables, usually due to insufficient local annuitant experience. In such a circumstance, insurers frequently make use of annuitant cohort tables from other countries having extensive annuity markets, and then they transform them to approximate their own national experience. This is the approach adopted in both Singapore (Fong 2001, 2002) and Australia (Knox 1999).[16]

Population cohort tables must almost always be derived from period life tables, which are published from time to time by statistical agencies. As with annuitant tables, these must be adjusted to match the year for which annuity pricing data are available. In addition, the tables must be transformed into cohort tables by incorporating projected mortality improvements. Typically these improvements are extrapolations of past mortality improvements recorded between two previous time periods for which life data have been collected. Where available, age-specific projected mortality improvements can also be incorporated.

The general algebraic formulation for linear cohortisation of a year 2000 period table is given by:

$$\hat{q}_x(2000+t) = q_x(2000) \times (1-a_x)^t \qquad (3)$$

where $q_x(2000)$ and $\hat{q}_x(2000+t)$ represent annual mortality rate for age x in year 2000 and estimated annual mortality rate for age x in year $2000+t$. a_x represents the estimated annual mortality improvement factors for an individual aged *x*.

For money's worth calculations, cumulative survival probabilities are required, given by:

$$\hat{p}_x = 1 - \hat{q}_x \qquad (4)$$

and

[15] Period tables describe the mortality rates of individuals at different ages in a given year. By contrast, cohort tables describe the mortality experience for a given birth cohort as it attains different ages. Therefore, to assess the expected value of an annuity purchased in 2000 by a 55-year old, we need a cohort table rather than a period table. For example, the chance that a 55 year old in 2000 will die at age 65, having survived to that age, will depend on the mortality rate of 65-year olds ten years from now, not on the mortality of current 65-year olds. See also McCarthy and Mitchell (2000).

[16] For further discussion on annuitant mortality tables see McCarthy and Mitchell (2000) and Mitchell and McCarthy (2000).

$$ {}_t\hat{p}_x = \prod_{k=0}^{t-1} \hat{p}_{x+k} \qquad (5) $$

where $\hat{p}_x$ is the probability of a person aged x surviving the year to age x+1, and ${}_t\hat{p}_x$ is the cumulative survival probabilities for a person aged x surviving t years. These are calculated for each age and gender on a monthly basis.

Figure 2 plots cumulative survival probabilities for males and females aged 65 in Australia and 55 in Singapore. The salient feature to be drawn is the substantial longevity advantage of both male and female annuitants in Australia, as compared to Singapore.

Figure 2 here

Singapore Mortality Calculations

Singapore population life tables may be obtained from Statistics Singapore or the World Health Organization (WHO).[17] They are similar except that the WHO tables report estimations for very old ages (85+). Since mortality patterns at advanced ages are critical for annuity pricing, we use the WHO variant.

Long term mortality improvement factors for Singapore are not available. In order to provide consistency in mortality improvement estimation for the two countries being considered here, we apply to both Australia and Singapore the 100 year improvement factors provided by the Australian Government Actuary (1999).[18]

Annuitant mortality experience in Singapore is limited, so the standard industry practice is to adopt the UK annuitant mortality experience, and adjust it for country-specific factors. The a90 mortality tables from the UK reflect individual annuitant experience, which is lagged by 2 years as required in the statutory reserving requirement of the Monetary Authority of Singapore. These are cohort tables, so no further adjustment is necessary.

Singapore Annuity Quotes and Interest Rates

On reaching age 55, Singaporeans have various options for securing their retirement income. As already discussed, one of these options is to purchase a life annuity from an approved insurance company with the minimum sum of $Sg 65,000. Annuities offered in the private market have a deferral period of 7 years until age 62. During this time, benefit payouts are not

[17] See Lopez et al (2001) for detailed life tables.

[18] The projected United Nation life expectancy trends are quite close in the two countries over the next 50 years. Mortality improvement adjustments based on past Singapore life tables imply projected Singapore life expectancy moving well ahead of long term Australian projections, which appears implausible. See UN Population Division website http://esa.un.org/unpp/ for the trends of life expectancy at birth in both countries.

made, so retirees must find alternative sources of income. On reaching the age of 62, annuity payments commence.

To conduct the money's worth calculation, we rely on an annuity design with a guarantee period of 15 years from the first payment. This contract can thus be broken down into three components: a 7-year term deposit (ages 55-62); a 15-year term annuity (ages 62-76); and a life annuity commencing at age 77. This decomposition makes it possible to compare annuities with similar features offered in other countries.

These calculations also rely on the company weighted average monthly payments from the insurance companies for a life annuity financed by the minimum sum, reported in Table 2.[19] We note that there is considerable variation between annuity issuers in the first-month payouts. For example, a nominal life annuity purchased for $65,000 by a 55 year-old male pays out between $468 and $600 per month (as of July 2000).[20] Table 2 also shows that the payouts for men are higher than those for women across the same annuity products. This reflects the fact that women on average live longer than do men, and the insurance company therefore expects to pay the annuity out over a longer period.

The final piece of information required to calculate a money's worth measure is the interest rate at which to discount the stream of payments to the present. To do this we use the term structure of yields on Treasury bonds to estimate the time series of expected future nominal interest rates over a 10 year horizon. The first year rate is derived from the June 2000 1 year T Bill, and the June 2000 2, 5, 7, and 10 year Treasury bond rates are used thereafter[21] for our central case assumption of long term discount rates. To eliminate the coupon effects, yields on zero coupon bonds are derived as a proxy for our term structure assumption. The estimated nominal short rate in each alternative period is obtained by linear interpolation.[22]

Australian Mortality Calculations

Money's worth values for Australian annuities are derived using a similar approach (Doyle, 2000). As in Singapore, the Australian annuity market is small, limiting the data available with which to derive an Australian annuitant table. For this reason, standard industry practice is to use UK annuitant tables, modified to represent the Australian population.

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[19] Details are available at http://www.cpf.gov.sg/cpf_info/home.asp

[20] Similar dispersion in annuity payouts have been detected in both the US and UK annuity markets (Mitchell *et al.*, 2000, Finkelstein and Poterba 2002).

[21] Sourced from the Dataroom on the Monetary Authority of Singapore website, found at www.mas.gov.sg.

[22] Because money's worth results are sensitive to the value of the interest rate, we report sensitivity analysis on this parameter in Table 7. Adverse selection estimates are relatively robust to interest rate variation.

Currently 60 per cent of the Individual Male 1980 and Individual Female 1980 (IM80/IF80) ultimate tables are used to benchmark annuitant mortalities in Australia, a standard recommended by the Institute of Actuaries of Australia.[23] This adjustment captures future mortality improvements, thereby effectively becoming a cohort mortality table.

Population cohort tables are generated from the Australian Life Tables (period tables) based on census data. These are adjusted by 100-year based mortality improvement factors provided by the Australian Government Actuary (1998) to generate population cohort tables.[24]

Australian Annuity Quotes and Interest Rates

Twelve Australian life offices have in-force life annuity business, but only 8 issuers are currently writing new business. For comparability with our Singapore results, the annuity quotes used here are the average values of quotes for December 2000. The annuity type examined is a nominal individual annuity with a 10-year guarantee feature for 65-year-old annuitants. The money's worth results are based on the first-year monthly payout from the annuity (see table 3).

Table 3 here

The term structure of yields on Treasury bonds is used to derive the time series of expected future nominal interest rates for Australia. The December 2000 1, 2, 3, 5 and 10-year Treasury bond rates (RBA 2001) are used to derive the spot rate term structure for yields on zero coupon bonds. Again, rates in other periods are linearly interpolated.

Money's Worth Results

Expected present values of the annuity products we have selected are computed using equations 1 and 2, and the data compiled on mortality, annuity payments, and interest rates for each country. Calculations are performed using both population and annuitant mortality (see Table 4). Turning first to the Singaporean results, and following the old-age benefit law, we assume that the retiree purchases a nominal annuity at the age of 55 for the minimum sum of $Sg 65,000, although payments do not commence until age 62. In the event that the annuitant dies during this period, the account balance reverts to the retiree's estate. Our results show that $1 of premium spent on purchasing a nominal life annuity by a 55-year old male drawn from the general population in 2000 would generate nearly 94.5 cents in annuity income (in net present value terms).

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[23] For Solvency standards, 60% of the IM80/IF80 tables are recommended. However, this is viewed as a rather conservative assumption. Annuity issuers tend to offer annuities on a more competitive basis.

[24] Further details are provided in Doyle (2000).

In Australia, the age 65 male retiree would anticipate receiving only 88 cents in the dollar. Thus Australian loadings are substantially higher than in Singapore. Our estimates are similar to those for the UK reported by Finkelstein and Poterba (2002), who find loadings of about 14 per cent for nominal annuities (using population mortality and the premium for a 65-year old male in 1998), but somewhat smaller than the 18 per cent reported for the US by Mitchell et al (2000) (using population mortality for a 65-year old male). On the other hand these US loadings are falling over time, probably due to increased market competition (Brown et al, 2000).

Table 4 here

It is worth asking whether the observed difference in loadings between Singapore, on the one hand, versus the Western countries, on the other, would shrink if annuitant mortality assumptions were used. The answer is 'yes': the loading for US nominal annuities purchased by 65-year old males using annuitant tables was only 8 per cent (Mitchell *et al.* , 2000); in the UK, Finkelstein and Poterba (2002) found a 5 per cent loading for the annuitant pool only. The corresponding loading in Australia for annuitants is 6.1 per cent, and in Singapore, 5.3 per cent, as reported in Table 4.

Insurance companies calculate their premiums knowing that annuitants are longer-lived than members of the general population. Given this, it is to be expected that the EPDV of actuarially fair annuities will be less than unity, based on general population cohort mortality tables. Also the EPDV of annuities based on annuitant cohort mortality tables would be expected to be uniformly higher. The difference between the money's worth of an annuity based on annuitant mortality and the money's worth of an annuity based on population mortality is our estimate of the extent of adverse selection in the life annuity market.

Our results, reported in table 5, show very small estimated differences in Singapore: the cost of adverse selection is only 0.26 percentage points for men and 1.84 percentage points for women. That is, adverse selection in the Singapore annuity market is small. By contrast in Australia the differences are larger, at more than 6 percentage points for men and 3.5 percentage points for women.

Table 6 here

These differences across the two countries could be consistent with several explanations. One we favour is that the overall structure of the national old-age system influences the way in which voluntary annuity markets work. Thus in Australia, the

government provides a pay-as-you-go minimum welfare benefit sufficient to prevent most elderly from falling into poverty. As a result, few people feel that they need to convert private wealth into an annuity, and consequently annuity penetration is low. The expectation is that only those for whom an annuity has a high expected value – the long-lived – will remain in the market, and thus adverse selection is high.[25]

In Singapore, by contrast, social assistance outside the CPF is rare. Partly due to this, adverse selection in the pool of annuity purchasers appears low and penetration rates are high. It is particularly interesting that this result holds, even though relatively few Singaporeans currently have sufficient liquid assets to attain the minimum sum threshold at age 55. That is, the group most able to purchase annuities is also more likely to represent the wealthier segment of the population. It is possible that this group may have greater longevity than the population at large, a factor that would only make the money's worth larger if adjusted for. While there insufficient evidence to prove this hypothesis, it is certainly consistent with the evidence.

It should also be recognised that the further the longevity insurance component of an annuity is deferred into the future, the more muted will be adverse selection. In the under examination, longevity insurance is effectively deferred 10 years in Australia, because of the guarantee feature of the annuity products considered. In Singapore, the longevity insurance component is deferred 22 years – 7years deferral plus a 15 year guarantee. This also helps to account for the difference in adverse selection effects in the two countries.[26]

Sensitivity Analysis

As noted earlier, annuitant mortality tables for Singapore and Australia are derived from UK annuitant tables and modified accordingly for each country. Sensitivity analysis helps determine how variations in mortality might affect our results. To do this, we modified the tables to allow for life expectancy to vary by two years on either side of our central case estimates, dated from the year of purchase. For Singapore, the mortality of a 53-year old then represents a –2-year adjustment and the mortality of a 57-year old represents a +2-year adjustment. The same 2-year adjustment is applied to the Australian annuitant mortality table with the base age of 65.

[25] This adverse selection problem is different from the moral hazard described by Smetters (2004) who examines how a minimum benefit guarantee might influence investment portfolio choice in a DC plan.

[26] We are indebted to Henry Jin for pointing this out. In addition, differences in prudential regulation requirements may also contribute to the differential in money's worth between the two countries.

Results appear in Table 6. Lightening mortality by two years exacerbates adverse selection, while the opposite holds when mortality is made heavier. In Singapore, the adjustments make more difference to the adverse selection results for males than females – lightening mortality by 2 years also results in the reversal of adverse selection for both genders. For the Australian case, making mortality 2 years lighter results in higher adverse selection and lower margins for the issuer on the annuity business.

Table 6 here

We also explore sensitivity to interest rate variations. The base case used government bond yield curves in both countries as of 2000. Risk free spot rates, proxying for yields on hypothetical zero coupon bonds were then derived for the term structure. Due to the lack of government bonds with terms beyond 10 years, we used the yields on 10 year zero coupon bonds as a proxy for the central case. Sensitivity testing using 50 basis points around the central cases shows that money's worth values are sensitive to these changes, as Table 7 indicates. Nevertheless, adverse selection remains robust.

Table 7 here

Our results in relation to earlier research.

Our results are quite compatible with previous work in this area (Knox 1999, Fong 2001, 2002). Focusing on results for male annuitants, we note that Knox (1999), used the 1990-1992 Australian Life tables and 1998 interest rates to derive a money's worth of Australian annuities with a 10 year guarantee of 88.8 per cent for a 65 year old male. For an annuitant, the value is 97.5 per cent, compared with our estimate of 93.9 per cent.

Fong (2002) reports money's worth of a 7 year deferred life annuity with a 15 year guarantee (a product comparable to ours) of 98.6 per cent for a 55 year old male in the general population, and 99.7 per cent for an annuitant. His mean cost of adverse selection is estimated at 1.1 per cent. Our corresponding estimates are 94.5 per cent for the general population and 94.7 per cent for an annuitant, with a cost of adverse selection of 0.3 per cent. It must be noted that Fong includes the NTUC annuity offer in his calculations, which we omit because the product offered is a participating annuity, and therefore does not strictly match the other annuity products considered.

Discussion and Conclusions

Despite their theoretical attractiveness, lifetime annuities have not been very popular in many developed country retirement portfolios, and voluntary annuity markets remain thin.

Possible explanations come to mind, including the possibility that (a) older people may not convert all their assets to annuities because they plan on bequeathing some of the funds to their heirs; (b) older people may avoid annuities believing they need to hold precautionary balances to cope with uninsurable events; and (c) older people may be over-annuitised given publicly-provided social security lifetime benefits.

Our research sheds light on this puzzle by evaluating money's worth ratios for Singapore and Australia. We show that while administrative loadings are present in both markets, more adverse selection is detected for Australia than for Singapore. Our central case estimates imply that on a population basis, Australian money's worth for a single life annuity with a 10 year guarantee is 87.9 per cent for a 65 year old male and 90.3 per cent for a 65 year old female. For an annuitant, money's worth is about 93.9 per cent for both sexes. This implies that the cost of adverse election is more than 6 percentage points for males, and 3.5 percentage points for females. By contrast, in Singapore, population money's worth for a 55 year old male is higher, at 94.5 per cent, and for a female 94.5 per cent. The corresponding values for an annuitant are 94.7 and 96.4 per cent, implying an adverse selection cost of 0.3 percentage points and 1.8 percentage points respectively.

These patterns are consistent with the fact that the generous old-age safety net benefit in Australia curtails the risk of old-age poverty, enabling people to avoid longevity risk. In Singapore, by contrast, no such guarantee is available. In other words, the defined contribution component of the two countries' retirement system is similar, but the extent of annuitization of retirement accumulations appears to respond to the existence of a retirement benefit guarantee. Additional explanations might include the possibility that annuity products in the two countries have different deferral periods.

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Table 1: Life annuity sales trends in Singapore: 1990 to 1999

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
No. annuities sold	380	720	1350	1510	1690	1970	2340	2550	2030	3200
% increase		90	85	14	12	17	19	9	-21	58

Source: Personal Communication, NTUC Office, Singapore July 2000.

Table 2: Monthly nominal life annuity payouts for 55-year old men and women in Singapore:
July 2000 (Sg $)

	Male	Female
	$ per month	$ per month
AIA	$468	$444
GE life	$585	$555
ICS	$575	$510
Keppel	$551	$504
UOB life	$600	$555
Average	***$555***	***$519***

Note: Monthly payouts are for a nominal annuity purchased at 55 with payments starting at age 62 and a 15-year guarantee period or similar. The premium is a government set minimum sum of Sg$65,000.
Source: Central Provident Fund (2000).

Table 3: Monthly nominal life annuity payouts for 65-year old men and women in Australia:
December 2000 (A$)

	Male	Female
	$ per month	$ per month
AMP	$658	$610
AXA	$682	$636
Challenger	$722	$669
Colonial	$648	$601
ING	$668	$619
MLC	$697	$651
Norwich	$586	$537
Tower	$665	$612
Average	***$666***	***$617***

Note. Monthly payouts are for a nominal annuity purchased at 65 with a 10 year guarantee period. Premium is A$100,000.
Source: Rice Kachor (2001)

Table 4: The money's worth of nominal life annuities in Singapore and Australia

Country	Sex	Annuitant mortality basis	Population mortality basis
Singapore	**Male**	**94.73%**	**94.47%**
	Female	**96.36%**	**94.51%**
Australia	**Male**	**93.89%**	**87.85%**
	Female	**93.83%**	**90.31%**

Note: Singapore annuitant mortality based on adjusted UK a90 annuitant tables (2 year lighter) and population cohort mortality based on Singapore 2000 population tables from WHO; annuity purchase at age 55; discounted at riskless term structure with long term rate assumption 4.76%. Australian annuitant mortality based on 60% of UK IM80/IF80 annuitant tables and population cohort mortality derived from Australian period population tables; annuity purchase at age 65; discounted at riskless term structure with long term rate assumption 5.46%.

Source: Authors' calculations; see text.

Table 5: Measured adverse selection in life annuity markets of Singapore and Australia

	Singapore	Australia
Male	**0.26%**	**6.04%**
Female	**1.84%**	**3.53%**

Table 6: Sensitivity to alternative mortality assumptions: Singapore and Australia

Country	Sex	Lag on annuitant mortality	Money's worth: Annuitant Mortality basis	Money's worth: Population Mortality basis	Adverse selection
Singapore	Males	2 yrs lighter	97.45%	94.47%	2.97%
		Central case	94.73%		0.26%
		2 yrs heavier	92.13%		-2.34%
	Females	2 yrs lighter	99.13%	94.51%	4.61%
		Central case	96.36%		1.84%
		2 yrs heavier	93.56%		-0.95%
Australia	Males	2 yrs lighter	97.09%	87.85%	9.24%
		Central case	93.89%		6.04%
		2 yrs heavier	90.68%		2.83%
	Females	2 yrs lighter	96.99%	90.31%	6.69%
		Central case	93.83%		3.53%
		2 yrs heavier	90.57%		0.27%

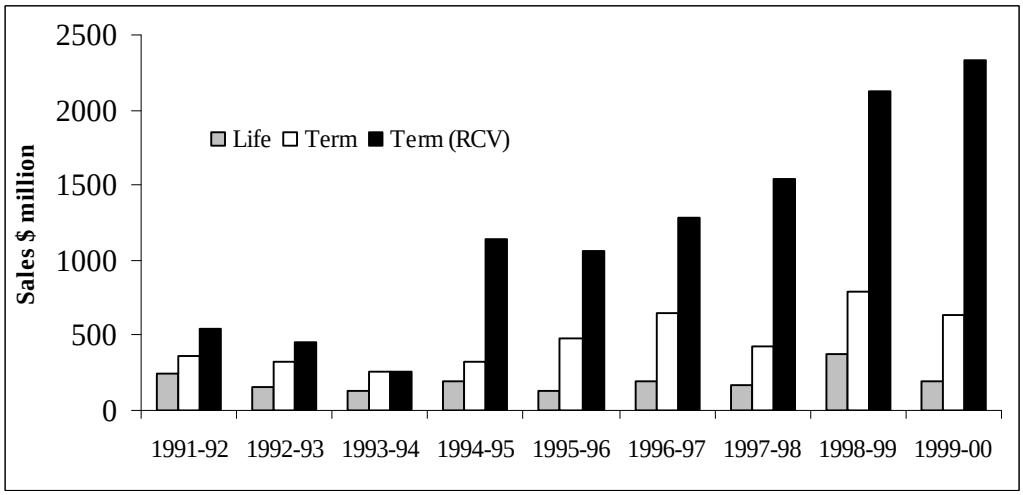
Source: Authors' calculations.

Table 7: Sensitivity to alternative long term discount rate assumptions: Singapore and Australia

Country	Gender	Long term rate	Money's worth: Annuitant Mortality basis	Money's worth: Population Mortality basis	Adverse selection
Singapore	Males	4.375%	101.43%	101.11%	0.32%
		4.875%	94.73%	94.47%	0.26%
		5.375%	88.68%	88.47%	0.21%
	Female	4.375%	103.83%	101.69%	2.14%
		4.875%	96.36%	94.51%	1.84%
		5.375%	89.66%	88.07%	1.59%
Australian	Males	5.050%	96.56%	89.89%	6.67%
		5.550%	93.89%	87.85%	6.04%
		6.050%	91.45%	85.98%	5.47%
	Female	5.050%	97.00%	93.05%	3.95%
		5.550%	93.83%	90.31%	3.53%
		6.050%	90.96%	87.80%	3.16%

Source: Authors' calculations.

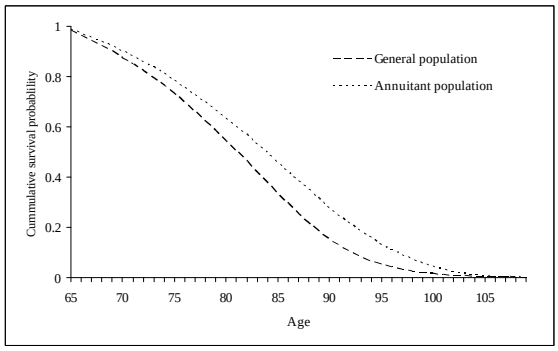
Figure 1: Immediate Annuity Sales in Australia ($A million)



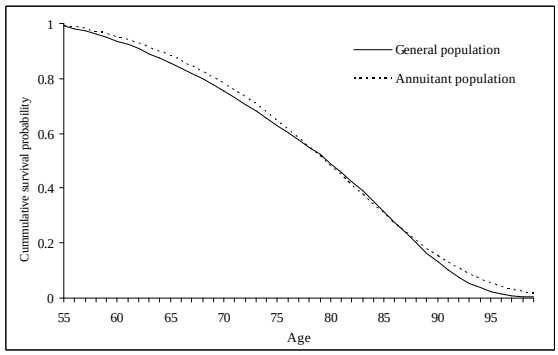
Source: Plan for Life Research (2000a).

Figure 2: Cumulative cohort survival probability — general and annuitant populations

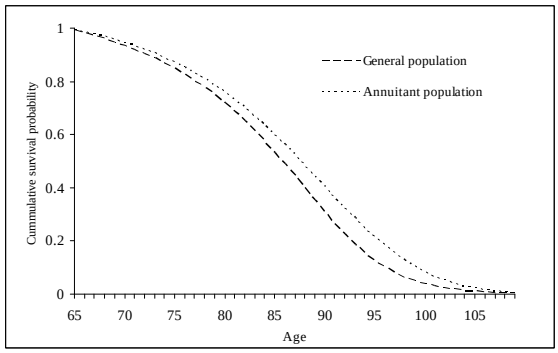
Australian males, 2000



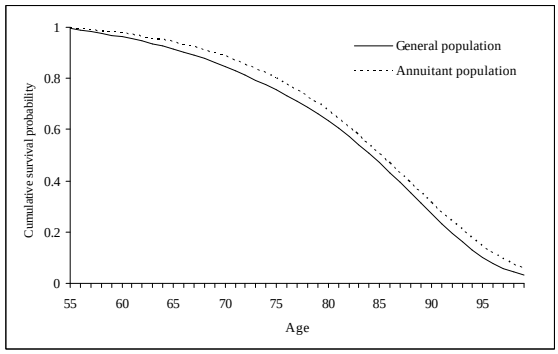
Singaporean males, 2000



Australian females, 2000



Singaporean females, 2000



Source: Authors' calculations. See text.