Annuity Values in Defined Contribution Retirement Systems: The Case of Singapore and Australia

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In this paper we derive and compare the value of life annuity products in an international context. Our specific goal is to assess the money’s worth and adverse selection impact of annuities in two countries – Singapore and Australia – which have mandatory DC-type retirement plans. This similarity in plan type is offset by differences in the two countries’ national retirement policies. Our comparison therefore exploits the natural experiment in annuity pricing and purchase behaviour under alternative retirement regimes. The results show that after controlling on administrative loadings, there appear to be important differences in measured adverse selection across countries.
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More older people are now looking ahead to their retirement years than ever before in world history. This global age wave has heightened awareness of the financial and mortality risks that confront retirees, risks that sometimes take people by surprise (Bodie 2000). Throughout much of the developed world, programs have been developed to provide a degree of social insurance against such risks. For example, public pension systems in many countries provide payments to the aged that help protect people against outliving their resources due to longevity risk and/or financial misfortune. Much the same motivation underlies the provision of defined benefit (DB)-type pension plans of the sort that until recently were the predominant form of private retirement provision in the Western world. These were typically configured to pay out a guaranteed retirement income stream linked to worklife earnings and that continued until death (McGill et al. 1996). Often survivorship benefits were also available under these plans.

In both sorts of defined benefit arrangement, risks are pooled across stakeholders – taxpayers, employees, and employers – and over time, to spread them cross-sectionally and intertemporally. By contrast, a rather different pattern of risk-bearing is taking shape as many countries adopt or enhance already-existing accumulation-based or defined contribution (DC) retirement systems. Either publicly-mandated or voluntarily provided, the DC model is characterized by specifying the contribution that must be made to the plan, usually as a fraction of employee earnings. This model has been adopted in several Asian countries via mandatory saving plans, systems that require workers and/or their employers to contribute a given fraction of earnings into a pension plan. Under this DC-type plan, there is typically little if any risk spreading between the plan stakeholders. That is, all participants have their own accounts, and the sponsor’s obligation typically ceases with the termination of labor services at retirement.

The DC-type pension plan has become a powerful engine for channelling workers’ earnings to retirement-saving purposes. These kinds of plans have also become an important source of retirement finance the world over (Palacios and Pallares-Miralles, 2000). Yet in the rush to design effective DC accumulation vehicles, there has thus far been too little attention
paid to how the plans will function during the *decumulation* phase. The specific problem that many of these plans therefore confront 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.

Economic analysis has previously demonstrated that products such as life annuities can play a key role in this process, working to ensure a degree of consumption smoothing through time.¹ Despite their theoretical attractiveness, empirical evidence from the US and the UK finds that few people hold annuities in their retirement portfolios and voluntary annuity markets remain thin. Reasons for this small demand to date are not well understood, but several possible explanations come to mind. First, older people may not convert all their assets to annuities because they plan on bequeathing some of the funds to their heirs. Second, older people may avoid annuities believing they need to hold precautionary balances to cope with uninsurable events. Third, older people in some countries already hold much of their wealth in annuitized form, due to publicly-provided social security lifetime benefits. As a result, they may not feel the need to avail themselves of additional voluntary annuities.

In the past, some evidence suggested that life annuity prices were rather high relative to population life expectancy and to alternative investment returns, but of late prices have been dropping steadily, at least in the US (Brown *et al.* 2000). Less well understood is the relationship between annuity prices and annuity returns in other countries, and this is the subject of our analysis below.

In what follows we first briefly review the retirement policy frameworks in Australia and Singapore. This comparison requires the calculation of annuity “money’s worth,” or the ratio of the expected present discounted value (EPDV) of an annuity to its purchase price. This provides an index of how good a deal an annuity offer is. We compare the money’s worth of individual annuities offered in Singapore and Australia, since both countries rely on a mandatory DC-type plan as their primary employment-linked compulsory retirement vehicle. However the two countries have sharply contrasting annuity markets and social welfare systems, as we shall show. Next we lay out the assumptions and methods used to calculate money’s worth of lifetime annuities. Results follow, along with a brief discussion of their potential relevance to other countries.
I. 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 percent, split between employers and employees, though the rate was 40 percent until the Asian crisis. Fund accumulations are used partly to provide a buffer to cover participant healthcare expenses (6 percent) 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 percent of the elderly receive social assistance from the government, and an emphasis is placed on family provision for the elderly. In addition, labour force participation among the elderly is high by developed-economy standards.

In Australia, by contrast, a relatively generous and means-tested social safety net insulates the elderly from destitution. By law, the minimum-income safety net is targeted so the monthly indexed pension for life amounts to 26 percent of average male full-time earnings for a single pensioner and 43 percent for a couple. This social insurance payment, along with the owner-occupied housing paid for over workers’ lifetimes, is the major source of retirement finance 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 percent receive some payment from this safety net program.

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1 See for instance Friedman and Warshawsky (1988, 1990), Warshawsky (1988), and Mitchell et al. (1999).
2 Throughout, domestic currencies are used for dollar values. As at July 2000, $US 1 = $Aus 1.76; and $US 1 = $Sg 1.8.
3 It is anticipated that the contribution rate will return to the 40 percent level in the future.
4 For a more detailed discussion on the Singaporean pension system see www.cpf.gov.sg and also Asher (1999), among others.
5 For more on the Australian retirement system see Bateman, Kingston and Piggott (2001)
In addition to the safety-net benefit, Australia has mandated a privately-managed defined contribution system termed the “Superannuation Guarantee” system. Under these rules, employers must pay 9 percent of earnings (phased in through 2002-03) to a pension fund, with the fund manager selected by the employer. Participating employees have some freedom over portfolio choice, subject to offerings provided by their fund manager. 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 uses for housing or education.

**Retirement Payouts in Singapore**

Singapore’s CPF design, with mandatory contributions of up to 40 percent, might lead one to conclude that Singaporean workers would reach retirement age having accumulated large holdings in their DC portfolios. However, this is not so, particularly given that the entire accumulation does not need to be preserved in the fund to retirement age. The bulk of the funds are actually used for investment in housing. As a result, retirement accumulations in the CPF financial portfolio are generally low by retirement age.

This outcome prompted a policy change in the early 1990s such that authorities began to require retirees to have what is termed a “minimum sum” at retirement – one that must be accumulated by age 55. The minimum sum is a lower-bound financial asset target that by law 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. 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. Financial accumulations up to the minimum sum cannot generally be taken as a lump sum at retirement. 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

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6 Legislative initiatives are pending to free up this restriction.
purchased an annuity, a rather large penetration rate 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.

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 percent 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 percent of payouts are currently in this form. By 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 termed “allocated annuities and pensions” in Australia. 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. A snapshot of this market indicates that allocated annuities and pensions attract the largest proportion of income stream capital, representing over 70 percent of total funds under management in July 2000. On the other hand, the combination of term and life annuities represents only 29 percent of the funds under management in Australia (see Figure 1).

Allocated products have characteristics quite different from other income stream products. First, there is no pooling of longevity risk so there is a chance that the annuitant could
run out of money before death. Second, the investment risk of retirement capital is entirely borne by the annuitant, and as such they can choose from an array of investment options. Of the total funds under management in allocated products, 63 percent are with managed funds, 23 percent in capital stable and 14 percent 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.\textsuperscript{8}

On the other hand, life and term annuities protect annuitants against rate of return risk. 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 percent 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).\textsuperscript{9} As seen in Figure 2, the recent incentive structure implemented in 1998 designed to encourage longevity annuities has not resulted in a large swing towards these types of income stream products.\textsuperscript{10}

\textit{Figure 2 here}

Available market data suggest that very few people in the retiring population buy genuine longevity annuities at retirement. In June 2000, there were 125,849 term and life annuity policies in force in Australia, of which one-quarter were life annuities and three-
quarters were term annuities. New sales are also highly skewed toward the term policy: in 1999, of 33,001 immediate annuity policies sold (worth SA 2.75 billion), approximately 3,000 were life annuities and 10,000 term annuities with no RCV. Based on Australian Treasury data, this indicates that only 3 percent of the estimated 100,000 Australians retiring each year purchased a life annuity.\footnote{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.} Turning to allocated annuities, by June 2000 the stock of recipients stood at some 244,000 people receiving allocated annuities/pensions, with sales of over $5.5 billion in the 1999-00 financial year (Plan for Life Research 2000b).

II. 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 survival). This latter contract is the simplest form of a life annuity. Annuities typically pay a lump sum (or single premium) to an annuity provider in return for the promised stream of payments. In a competitive market without 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. (2000). 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, voluntary private annuity markets in the US, for instance, 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 - 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. One interesting finding thus far is that in the US, nearly half of the disparity between the expected discounted value of the payouts and the policy premium appears to be due to adverse selection. In the UK, adverse selection also accounts around half of the total loading on voluntary annuities (Finkelstein and Poterba, 1999).

### 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:

\[
EPDV(\text{nominal}) = \sum_{t=1}^{N+1} \frac{A_x}{(1 + r_t)^t} + \sum_{t=(N+1)+1}^{(w-x)+1} \frac{A_x \cdot p_x}{(1 + r_t)^t}
\]

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 monthly annuity rate at the age of purchase; \(p_x\) 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 used to purchase the annuity:

\[
MW = \frac{EPDV(\text{nominal})}{K}
\]

There are three important variable inputs to the EPDV calculation: the annuity market quote, the interest rate used to discount the annual payment, 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 mortality improvement, \(^{15}\) and thus they provide the basis for calculating how long an individual might be expected to live.

When 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 transform them to approximate their own national experience. This is the approach adopted in both Singapore and Australia. \(^{16}\)

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

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\(^{12}\) See Finkelstein and Poterba (1999) and Murthi et al. (1999). Work in progress by James and Vittas (1999) explores a similar question in a range of other countries.

\(^{13}\) 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, if possible, for money’s worth valuations.

\(^{15}\) Period tables describe the mortality rates of individuals at different ages in a given year. On the other hand, cohort tables describe the mortality experience for a given birth cohort as it reaches different ages. Therefore, to value 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).
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.

Charts 3 and 4 plot cumulative survival probabilities for both males and females aged 65 in Australia and 55 in Singapore. The salient feature to be drawn from them is the greater prominence of differential annuitant mortality for both males and females in Australia.

**Singaporean Mortality Calculations**

Singapore’s Department of Statistics publishes life tables for the population based on census data approximately every decade. The most recent life tables available were derived from 1990 data, and they are period tables: that is, they provide information about mortality of a cross-section of ages at a point in time and make no allowance for improvements over a cohort’s lifetime. To transform these 1990 Singapore population tables into a form where they may be used to estimate annuity money’s worth, two separate operations must be undertaken: first the 1990 tables must be “aged” to 2000, and then they must be “cohortized”.

To explain the process, aging the Singapore population table involves incorporating mortality improvements for each age and gender combination into the most recent period table. We estimate future mortality improvements by extrapolating past improvements implied by mortality changes between the 1990 and 1980 population tables. Specifically, the mortality improvement over the decade is given by:

\[
\alpha_x(1990 - 1980) = \frac{q_x(1990)}{q_x(1980)}
\]

where \(\alpha_x(1990 - 1980)\) is the mortality improvement rate over the 10 years for each age (represented by \(x\)) and gender combination. These rates are then applied to the 1990 mortality rated to find the 2000 rates:

\[
q_x(2000) = \alpha_x(1990-1980) \times q_x(1990)
\]

where \(q_x(2000)\) is the period mortality probability for an age \(x\) individual in 2000.

The resulting period population table for 2000 then must be “cohortized”. This process relies on the mortality improvement factors given by (3), but it also requires a separate

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17 These have been drawn from Swee-Hock (1981) and Tan (1996). Dr Tan kindly supplied us with annualized 1990 life tables.
adjustment for each age cohort. For individuals of age $x$ in the year 2000, the cohort mortality rate $(\hat{q}_x)$ is defined as follows:

$$\hat{q}_x(2000) = q_x(2000) \times \left(1 + \frac{-\alpha_x}{100}\right)^0$$

(5)

where $\alpha_x$ now represents the estimated annual mortality improvement for an individual aged $x$. In (5), no change results. But a year later, the expectation of survival will be improved at a rate assumed to be equal to the annual mortality improvement for individuals aged $x+1$. This is given by:

$$q_{x+1}(2001) = q_{x+1}(2000) \times \left(1 + \frac{-\alpha_{x+1}}{100}\right)^1$$

(6)

Two years on, the mortality of the cohort is given by

$$q_{x+2}(2002) = q_{x+2}(2000) \times \left(1 + \frac{-\alpha_{x+2}}{100}\right)^2$$

(7)

In general, cohortization of a period table is given by:

$$\hat{q}_{x+t}(2000 + t) = q_x(2000) \times \left(1 + \frac{-\alpha_{x+t}}{100}\right)^t$$

(8)

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

$$\hat{p}_{x+t} = 1 - \hat{q}_{x+t}$$

(9)

$$t \hat{p}_x = \prod_{t=1}^{(x-a)} \hat{p}_{x+t}$$

(10)

where $\hat{p}_{x+t}$ 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.

Annuitant mortality experience in Singapore is limited, so the standard industry practise is to adopt the annuitant mortality experience of the UK, and adjust it for country specific factors. The a90 mortality tables from the UK reflect individual annuitant experience, which is lagged by 3 years to allow for country differences. 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 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 base our computations on an annuity design with a guarantee period of 15 years from the first payment. The annuity 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. A considerable variation between annuity issuers is 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). Similar dispersion in annuity payouts have been detected in both the US and UK annuity markets (Mitchell et al., 2000, Finkelstein and Poterba 1999). 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.

*Table 2 here*

The final piece of information required to calculate a money’s worth is the interest rate at which to discount the value of income payments made over time to the present value. To do this we make assumptions about the term structure of future short term nominal interest rates. The term structure of yields on Treasury bonds are used to estimate the time series of expected, future, nominal short term interest rates. The first year rate is derived from the December 2000 1 year T Bill, and the December 2000 2,5,7, and 10 year Treasury bond rates are used.

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thereafter\textsuperscript{19}. The estimated nominal short rate in each alternative period is calculated as the average of the two adjacent long term bonds.

\textbf{Australian Mortality Calculations}

Money’s worth values for Australian annuities are derived using a similar approach to that used for Singapore (\textit{see} 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 annuitant tables from the UK and modify them to represent the Australian population. Currently 60 percent 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 Australian Institute of Actuaries\textsuperscript{20}. 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.\textsuperscript{21}

\textbf{Australian Annuity Quotes and Interest Rates}

There are 13 Australian life offices with in-force life annuity business. However, there are only 9 issuers currently writing new business. The annuity quotes used in the money’s worth calculation are the average company weighted value of quotes for December 2000. The annuity type chosen 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. The industry average is given in Table 3.

\textit{Table 3 here}

The term structure of yields on Treasury bonds are used to estimate the time series of expected, future, nominal short term interest rates for Australia. The December 2000 1,2,3,5 and 10 year Treasury bond rates are used (RBA 2001) to estimate the term rates. Again, the bond rates adjacent to two long bond rates are estimated on an average basis.

\textsuperscript{19} Sourced from the Dataroom on the Monetary Authority of Singapore website, found at www.mas.gov.sg.

\textsuperscript{20} 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.
III. Money’s Worth Results

Taking the information on mortality, annuity payments and interest rates for each country, the EPDV can be calculated according to equations 1 and 2. The calculations are performed using both population and annuitant mortality.

Turning first to the money’s worth calculations for Singaporean annuities, results appear in Table 4. It is assumed that a 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. These results are to be interpreted as follows: $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 108 cents in annuity income (in net present value terms). This implies that the annuity issuer is charging a negative fee for its services. Given the term structure and mortality data we have used, an actuarially fair annuity would deliver a monthly income of $515. The company average annuity quote we are using is much higher than this, at $555.

This is not the first time that money’s worth ratios exceeding unity have been found for Singapore. James and Vittas (1999) report ratios as high as 125%. One possible explanation is that falling government bond rates over this period have not led to immediate adjustments in annuity quotes. For example, if the 1999 dated (????) term structure used by James and Vittas is applied to our calculations, our ratios fall to 97.64% for male annuitants, and 99.47% for female annuitants when calculated with general population mortality assumptions.

James and Vittas point out that it is possible for insurance companies to bear some risk in their investments, and report that in Singapore, one third of all insurance company investments were in equities and another quarter in real estate and loans. A further point is that if annuities are a relatively new product in a financial market, insurance companies may price aggressively to build business. While annuity business is only a small part of overall insurance business, the company will be able to cover any annuity losses out of its other income.

Finally, it may be that in Singapore, where many corporations are government-run, corporate bonds are regarded as very safe investments. If an adjustment (of 1 per-cent) is made

21 Further details are provided in Doyle (2000).
to our government bond term structure to allow for higher corporate rates, then the money’s worth ratios are 92.79% for male annuitants, and 94.19% for female annuitants.\footnote{James and Vittas argue that if individuals prefer some exposure to risk in their annuity purchases, but are constrained to buy only safe annuities, then the appropriate discount rate to apply is the corporate rate.}

Table 5 here
The money’s worth values reported in Table 5 for Australia indicate substantially higher loadings: eg. just over 11 percent for an annuity sold to a 65-year old male drawn from the general population. These estimates echo those reported in the UK: Finkelstein and Poterba (1999) report loadings of about 14 percent in a nominal annuity, using population mortality and the premium for a 65-year old male in 1998. These are somewhat smaller than those reported for the US for 1995. Mitchell et al (2000) report that for a nominal annuity priced using the population mortality for a 65-year old male, the loading accounts for 18.4 cents out of a $1 premium. These loadings have declined over time, however, perhaps due to increased market competition (Brown et al, 2000).

Table 6 here
It is worth asking whether the observed difference in loadings between Singapore, on the one hand, and the US and UK, on the other, shrinks when annuitant mortality assumptions are used. The loading for US nominal annuities purchased by 65-year old males using annuitant tables was only 8 percent (Mitchell et al., 2000); in the UK, Finkelstein and Poterba (1999) found a 5 percent loading for the annuitant pool only. The corresponding loading in Australia for annuitants is also 5 percent. In Singapore, the loading is again positive, implying there is no loading on the annuity. A positive result on the loading implies that private companies issuing annuities are not making any money on the business that they write.

IV. Evidence of Adverse Selection
Insurance companies calculate their premiums knowing that annuitants are longer-lived than members of the general population. Given this, it is 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.

This translates into different annuitant values for Singapore and Australia, presented in Table 6. The results show a very small estimated difference in Singapore. For instance, for a nominal annuity purchased by a 55-year old male, the cost of adverse selection is apparently tiny: only 0.69 for men and –1.02 percent for women. That is, adverse selection in Singapore apparently accounts for a minuscule fraction of the total life annuity loading. In fact, for women adverse selection analysis leads to the perverse result that money’s worth for population mortality is greater than for annuitant mortality. This result is an implication of the adjustment made to the raw annuitant and population mortality estimates, and is indicative of the very small mortality differences between these two groups. To an approximation, the annuitant tables used and associated adjustments reflect cohort population mortality.

By contrast in Australia the differences are larger, at 6 percentage points for men and 3.6 percentage points for women.

Table 7 here

These results might be consistent with the idea that provision of social welfare can adversely affect the efficiency of voluntary annuity markets. That is, the Australian government provides a guaranteed old-age pension sufficient to prevent most elderly from falling into poverty. As a result, few people see the need to convert private wealth to annuities, and consequently annuity penetration is low and adverse selection is high.23 However, there is not sufficient evidence here to support this hypothesis fully. 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 high. It is interesting that this result holds even though the subset of Singaporeans with enough liquid assets to attain the minimum sum threshold at age 55, and therefore the group able to purchase annuities, is likely to represent the wealthier segment of the population. This group could be anticipated to have greater longevity than the population at large. Only a small number of annuities have thus far been sold in Singapore, but it appears that penetration rates among new retirees is high by international norms.

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23 This adverse selection problem is different from the moral hazard described by Smetters (forthcoming) who examines how a minimum benefit guarantee might influence investment portfolio choice in a DC plan.
V. Annuitant mortality sensitivity

As discussed in the paper, the annuitant mortality tables for Singapore and Australia are derived from UK annuitant tables and modified accordingly for each country. We therefore carried out sensitivity analysis to see how variations in mortality affect our results.

To do this, we modified our mortality tables to allow for life expectancy to vary by two years either side of our central case estimates, dated form the year of purchase. For Singapore, the mortality of a 53 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.

Chart 5 shows how the adjustment changes the cumulative survival probability for Singaporean males. The results are presented in Table 7. The –2 year adjustment exacerbates adverse selection, while the +2 year adjustment reduces adverse selection, relative to the base case results reported in table 6.

For Singapore, the –2 year adjustment results in significant adverse selection for both genders. For the Australian case, the –2 year adjustment results in higher adverse selection and lower margins for the issuer on the annuity business.

VI. Discussion

We have devised and employed a money’s worth framework to value life annuities and to measure the extent of adverse selection in Australia and Singapore. Our findings indicate some interesting international patterns. Specifically, administrative loadings are present in both markets, but the degree of selection in the annuity markets differs, with more adverse selection in Australia than in Singapore.

There are several possible explanations for these patterns. It is possible that annuity purchase in Singapore is more widespread because of the availability of a generous old-age safety net benefit in Australia that dramatically curtails the risk of old-age poverty. In Singapore 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.

Equally, however, in Singapore retirees are not free to dispose of CPF accumulations in any way they wish. Given the high money’s worth ratios on annuities, it may be that annuities
are simply a better buy in Singapore than the alternatives of bank or CPF deposits. Future research will explore these issues, both in the Singapore context, and with data from additional countries.
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James, Estelle and Dimitri Vittas. 1999. “Annuities Markets in Comparative Perspective”. 


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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. annuities sold</td>
<td>380</td>
<td>720</td>
<td>1350</td>
<td>1510</td>
<td>1690</td>
<td>2340</td>
<td>2550</td>
<td>2030</td>
<td>3200</td>
<td></td>
</tr>
<tr>
<td>% increase</td>
<td>90</td>
<td>85</td>
<td>14</td>
<td>12</td>
<td>17</td>
<td>19</td>
<td>9</td>
<td>-21</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>


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

<table>
<thead>
<tr>
<th></th>
<th>Male $ per month</th>
<th>Female $ per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIA</td>
<td>$468</td>
<td>$444</td>
</tr>
<tr>
<td>GE life</td>
<td>$585</td>
<td>$555</td>
</tr>
<tr>
<td>ICS</td>
<td>$575</td>
<td>$510</td>
</tr>
<tr>
<td>Keppel</td>
<td>$551</td>
<td>$504</td>
</tr>
<tr>
<td>UOB life</td>
<td>$600</td>
<td>$555</td>
</tr>
<tr>
<td>Average</td>
<td>$555</td>
<td>$519</td>
</tr>
</tbody>
</table>

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: June 2000 (A$)

<table>
<thead>
<tr>
<th></th>
<th>Male $ per month</th>
<th>Female $ per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMP</td>
<td>$658</td>
<td>$610</td>
</tr>
<tr>
<td>AXA</td>
<td>$682</td>
<td>$636</td>
</tr>
<tr>
<td>Challenger</td>
<td>$722</td>
<td>$669</td>
</tr>
<tr>
<td>Colonial</td>
<td>$648</td>
<td>$601</td>
</tr>
<tr>
<td>ING</td>
<td>$668</td>
<td>$619</td>
</tr>
<tr>
<td>MLC</td>
<td>$697</td>
<td>$651</td>
</tr>
<tr>
<td>National Australia</td>
<td>$697</td>
<td>$651</td>
</tr>
<tr>
<td>Norwich</td>
<td>$586</td>
<td>$537</td>
</tr>
<tr>
<td>Tower</td>
<td>$665</td>
<td>$612</td>
</tr>
<tr>
<td>Average</td>
<td>$669</td>
<td>$621</td>
</tr>
</tbody>
</table>

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 an nominal life annuity purchased in Singapore at age 55, based on annuitant and population cohort mortality

<table>
<thead>
<tr>
<th>Annuitant mortality basis</th>
<th>Population mortality basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>108.46%</td>
</tr>
<tr>
<td>Female</td>
<td>111.35%</td>
</tr>
</tbody>
</table>

Note: Singapore annuitant mortality based on UK a90 annuitant tables and population cohort mortality derived from Singapore period population tables. Discounted at riskless term rates.

Source: Authors’ calculations; see text.

### Table 5: The money’s worth of an nominal life annuity purchased in Australia at age 65, based on annuitant and population cohort mortality

<table>
<thead>
<tr>
<th>Annuitant Mortality basis</th>
<th>Population Mortality basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>95.03%</td>
</tr>
<tr>
<td>Female</td>
<td>95.12%</td>
</tr>
</tbody>
</table>

Note: Australian annuitant mortality based on UK IM80/IF80 annuitant tables and population cohort mortality derived from Australian period population tables. Discounted at riskless term rates.

Source: Authors’ calculations; see text.

### Table 6: Measured adverse selection in life annuity markets of Singapore and Australia

<table>
<thead>
<tr>
<th></th>
<th>Singapore</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0.69%</td>
<td>6.18%</td>
</tr>
<tr>
<td>Female</td>
<td>-1.02%</td>
<td>3.62%</td>
</tr>
</tbody>
</table>
Table 7: Sensitivity results based on different mortality assumptions: Singapore and Australia

<table>
<thead>
<tr>
<th>Country</th>
<th>Lag on annuitant mortality</th>
<th>Gender</th>
<th>Money’s worth</th>
<th>Adverse selection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Annuitant Mortality basis</td>
<td>Population Mortality basis</td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>- 2 yrs</td>
<td>Males</td>
<td>111.91%</td>
<td>107.77%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Females</td>
<td>114.82%</td>
<td>112.37%</td>
</tr>
<tr>
<td></td>
<td>+ 2 yrs</td>
<td>Males</td>
<td>105.09%</td>
<td>107.77%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Females</td>
<td>107.79%</td>
<td>112.37%</td>
</tr>
<tr>
<td>Australia</td>
<td>- 2 yrs</td>
<td>Males</td>
<td>98.31%</td>
<td>88.85%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Females</td>
<td>98.36%</td>
<td>91.50%</td>
</tr>
<tr>
<td></td>
<td>+ 2 yrs</td>
<td>Males</td>
<td>91.75%</td>
<td>88.85%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Females</td>
<td>91.78%</td>
<td>91.50%</td>
</tr>
</tbody>
</table>
Figure 1: Funds Under Management in the Australian Income Stream Market (%)

Source: Plan for Life Research (2000a); (June 2000)

Figure 2: Immediate Annuity Sales in Australia ($A million)

Source: Plan for Life Research (2000a); (July 2000)
Chart 3a: Cumulative cohort survival probability — general and annuitant populations
Australian males, 2000

Chart 3b: Cumulative cohort survival probability — general and annuitant populations
Australian females, 2000
Chart 4a: Cumulative cohort survival probability — general and annuitant populations
Singaporean males, 2000

Chart 4b: Cumulative cohort survival probability — general and annuitant populations
Singaporean females, 2000
Chart 5: Sensitivity of Singaporean annuitant mortality: Males

Cumulative survival probability

Age

base case  - 2 years  + 2 years