Australian Longevity Index: A Technical Note

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Abstract

This paper outlines the methodology for construction of an Australian Longevity Index. The aim of the index is to quantify the impact of changes in Longevity on the affordability of retirement. Retirement affordability depends on many factors including investment earnings, inflation as well as the risk of outliving savings. The index is based on the amount of funds required to finance an income stream in real terms allowing only for longevity risk with a specified probability assuming interest rates and inflation rates are fixed at levels at the time of computation of the index.

1 Introduction

This paper describes the construction of a Longevity Index for Australia that is based on the amount of funds required to finance an income stream in real terms allowing for Longevity risk with a specified probability based on current life tables and assuming interest rates and inflation rates are fixed at levels at the date of calculation of the index. The index aims to reflect the impact of longevity risk on the ability of an individual to finance constant real consumption over their remaining lifetime. Since the aim is to capture longevity risk and not investment or inflation risk, current interest rates and inflation rates are used without any allowance for their impact on the chance of financing the real level of consumption at the date of computation of the index. The index will reflect changes in interest rates and inflation rates through time as well as changes in longevity but will only quantify longevity risk.

2 Index Assumptions

The index aims to measure the amount required by an individual at retirement age to provide a constant level of real consumption throughout their retirement. Longevity risk is the risk that they will outlive their savings because of the natural variability in their life time. Other risks include investment and inflation risks. The index quantifies longevity risk only and uses fixed rates, at levels
current for the date of computation of the index, for investment interest rates and inflation rates. Investment and inflation rates reflect current levels at the date of construction of the index to control for changes in these economic factors but the risk of outliving savings because of high inflation or low investment returns is not included in the Longevity index. The index is determined for both males and females.

The index is calculated as the amount required that will with probability at least \(1 - \alpha\) provide an individual aged \(x\) with real consumption of \(1\) p.a. throughout their life. Consumption is assumed to take place at the start of the year. A proportion \(\alpha\) of the time the index amount will not be sufficient to provide the real consumption of \(1\) p.a. This concept is similar to that of value-at-risk (VaR) used in financial firms to quantify risk. If the index at age \(x\) is denoted by \(I_x\) then this amount will be insufficient to fund real consumption up to the time of death if the accumulated amount of the index in real terms is not sufficient to fund the accumulated value of real consumption or

\[
I_x \left( \frac{1 + i}{1 + f} \right)^T - \left\{ \left( \frac{1 + i}{1 + f} \right)^T + \left( \frac{1 + i}{1 + f} \right)^{T-1} + \ldots + 1 \right\} < 0
\]

where death occurs at age \(x + T\) last birthday or later, the constant interest rate is assumed to be an effective rate of \(i\) p.a., and the inflation rate is assumed to be an effective rate of \(f\) p.a. with \(i > f\). This can be rewritten as

\[
I_x - \left\{ 1 + \left( \frac{1 + f}{1 + i} \right)^2 + \ldots + \left( \frac{1 + f}{1 + i} \right)^T \right\} < 0
\]

\[
I_x < \frac{1 - \left( \frac{1}{1+r} \right)^{T+1}}{1 - \left( \frac{1}{1+r} \right)} = \frac{(1 + r) - \left[ \frac{1}{1+r} \right]^T}{r}
\]

where

\[
\frac{1}{1+r} = \frac{1 + f}{1 + i}
\]

The probability that an individual will die at age \(x + T\) last birthday or later is

\[
1 - T-1 p_x \leq \alpha
\]

Now let the \(T^*\) be the first age such that

\[
1 - T^* p_x \leq \alpha
\]

The index is given by

\[
I_x = \frac{(1 + r) - \left[ \frac{1}{1+r} \right]^{T^*}}{r}
\]

The index is based on the latest life tables from the ABS and the Australian Government Actuary.
3 Data

Reliable, publicly available data is required for interest rates, inflation rates as well as for survival probabilities. A long term interest rate that reflects risk free investment returns should be used to reflect the long term nature of the expected consumption cash flows and a government interest rate to eliminate any effect from credit risk. The current inflation rate based on the CPI should be used for inflation to avoid any subjective element from inflation expectations. The latest Australian population life tables for both males and females should be used both without and with an allowance for mortality improvement. Mortality improvement should use publicly available independent improvement factors and should include the uncertainty from including improvement trends.

3.1 Interest rates

The Reserve Bank of Australia provides 10 year Australian Government Bond yields on a monthly and these are available in Table F02 CAPITAL MARKET YIELDS - GOVERNMENT BONDS commencing July 1969. The latest month available at 1 May 2009 is March 2009.

3.2 Inflation rates

For inflation the CPI All groups index is available from the Reserve Bank of Australia Table G02 CONSUMER PRICE INDEX on a quarterly basis commencing September 1969. This index data is sourced from the ABS. The latest quarter available at 1 May 2009 is March 2009. The rates used are annual year-on-year rates. The dates of release of CPI index data by the ABS are:

<table>
<thead>
<tr>
<th>ISSUE (QUARTER)</th>
<th>Release Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2009</td>
<td>22 July 2009</td>
</tr>
<tr>
<td>September 2009</td>
<td>28 October 2009</td>
</tr>
<tr>
<td>December 2009</td>
<td>27 January 2010</td>
</tr>
<tr>
<td>March 2010</td>
<td>28 April 2010</td>
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3.3 Life Tables

Life tables are published by the ABS on an annual basis. They are based on three years of deaths and population data. The deaths and population data are based on Australian residents who are physically present in Australia over the three-year period so that Australian residents temporarily overseas are excluded. They are actuarially graduated on the same principles used for the quinquennial Australian life tables prepared by the Australian Government Actuary. Tables readily available from the ABS web site are:


The Australian Government Actuary publishes Australian Life Tables every five years based on the census data. Australian Life Tables 2005-07 will be published by the end of September 2009 because data required on late death registrations will not become available from the ABS until mid June 2009. This is later than normally available. The SoA Table Manager has the Australian Life Tables since 1881-1890. Early tables are every 10 years and later tables are every 5 years corresponding to the timing of censuses.

The Australian Government Actuary also publishes improvement factors based on 25 year and 100 year trends. The latest improvement factors from the Australian Government Actuary is for the Australian Life Tables 2000-02. The ABS also uses improvement factors for the purposes of its population projections.

4 Index Construction

The index is readily updated quarterly to reflect the latest inflation rates and interest rates and annually to reflect the latest mortality tables. Allowance can also be made for expected improvement in mortality. Initially the index can be constructed based on the ABS Life Tables going back to the beginning of 2003 and then updated annually for the latest Life Table and quarterly for the latest CPI and interest rates. Life Tables are released around end November for the previous year so that the December index can be updated for the latest mortality table from the ABS. Interest rates and inflation rates are available approximately 4 to 6 weeks after the end of the quarter.

The index is constructed for males and females separately and for ages 55, 60, 65 and 70. Index values are constructed without including mortality improvement based on the latest official publicly available life table.

5 Index research topics

There are a number of research topics that can be based on the index. These will lead to enhancements to the index. These include constructing an annual index series back to the turn of the 20th century using available Life Tables, estimates of inflation and long term interest rates. Annual historical data on RPI/CPI is available going back to 1901.

An investigation into the allowance for improvement trends and the uncertainty of projected mortality rates would incorporate risk in the estimated probability of survival from the life tables.

Milevsky (2006) develops a simplified model that can be used to investigate an allowance for volatility in investment earnings on the index.
The ABS publishes state based Life Tables and these can be used to investigate the impact of geographical location on mortality risk.

6 References