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Edward Leung

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Centre for Actuarial Studies
Department of Economics
The University of Melbourne
Victoria 3010 Australia

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EDWARD LEUNG*

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ABSTRACT

We propose an *n*-year roll forward reserve model for a social LTC insurance scheme that may be introduced in Australia. Using the projected future needs and costs of LTC as derived in Leung (2004a), we calculate the likely contribution requirements to maintain 1-year, 2-year and 4-year level roll forward reserves for a hypothetical Australian Commonwealth government administered social LTC insurance scheme in Australia and to derive short term reserve profiles for such a fund over the next 50 years.

KEYWORDS

Long Term Care; Social Insurance; Private Insurance; Roll-forward Reserves

CONTACT ADDRESS

E. Leung, B.Com (Hons); LL.B (Hons); AIAA. Ph.D Candidate, Centre for Actuarial Studies, Faculty of Economics and Commerce, University of Melbourne, Parkville, 3010 AUSTRALIA. Tel. +61 3 83447939; E-mail: e.leung@pgrad.unimelb.edu.au

1 Introduction

The purpose of this paper is to propose and investigate a social insurance model for the financing of future LTC requirements in Australia. A social insurance scheme is a possible alternative to the current program of extensive Commonwealth subsidy, or even the development of a comprehensive private LTC insurance market. The specific goals of this paper are to inform on likely contribution requirements for a publicly administered social LTC insurance scheme in Australia and to derive short term reserve profiles for such a fund over the next 50 years. We propose here an Australian social LTC insurance scheme to be administered by the Commonwealth where benefits are provided to any person requiring LTC, irrespective of age, funded from contributions based on a percentage of yearly taxable income by all employed persons in the population, irrespective of age or income level. Note that we will only be considering the benefit and contribution aspects of the scheme thereby reflecting the underlying LTC risk of which we are concerned in this paper. We refrain from discussing issues such as fund administration and costs.

The paper begins with a literature review of current methodologies employed in social insurance modelling, previous work on social LTC insurance modelling in Australia and a description of the *n*-year roll forward reserving framework employed in this paper. We then detail the main parameters of the model, their respective data sources and our forecasting methodologies. We then calculate and present contribution requirements and reserve profiles for the fund followed by an analysis of the results with respect to sensitivities in the forecast parameters. Finally, we discuss the conclusions to this study, their limitations and avenues for further research.

We stress that our model requires exceedingly long term disability, population and macro-economic forecasts. As such, our results should be read as scenario investigations as opposed to providing precise solutions.

2 Literature Review

The social insurance modelling literature encompasses many branches of social security such as social unemployment insurance, public pension benefits and acute health care insurance such as Medicare. The methodologies employed in social insurance modelling are generally applicable to all branches of social security – the only source of difference being the nature of the liabilities (e.g unemployment benefits as opposed to LTC benefits). Here, we briefly discuss the alternative methodologies in social insurance modelling generally, the current Australian literature in the LTC context and the framework ultimately employed in this paper.

2.1 Microsimulation Modelling versus Discounted Cash Flow Analysis

The methodologies employed in social insurance modelling may typically be classified as either a form of projected cash flow analysis or microsimulation modelling. A projected cash flow methodology usually involves a deterministic approach to systematically accumulating revenue to provide for social insurance benefits to be distributed rationally over time. Plamondon et al. (2003) present a straightforward generic framework for computing pay-as-you-go (PAYG) contribution rates and target reserve ratio contribution rates with general applicability to social LTC insurance. A clear advantage of projected cash flow modelling is its conceptual simplicity and non-reliance on detailed micro data. A valid criticism, however, is its inability to fully capture the dynamics of an inherently complex social security system.

An alternative methodology is dynamic microsimulation modelling where the behaviour and interaction of individual units within an economic system are simulated and projected forward. Aeschimann et al. (1999) present a model employing microsimulation techniques for the social contributions to the Swiss Old Age and Survivor Insurance scheme by tracing the progress of individuals through the labour market, estimating theoretical distributions of labour income and consequently determining relevant contribution rates. Rivlin (1990) also uses a dynamic microsimulation model to examine the possibility of public LTC insurance for the US. Despite both these studies demonstrating the feasibility of microsimulation techniques as a useful tool in social insurance modelling, we have chosen not to pursue a microsimulation approach in this paper and instead pursue a methodology based on a projected cash flow framework. We feel that this is more appropriate for the following reasons. First, there appears to be no suitable unit record file on individual units for LTC in Australia that may be used in a microsimulation model. Projected cash flow analysis is significantly less data intensive and allows the use of aggregated data which is more widely available. Second, given the long time horizon considered in this study and the inevitable uncertainty of future demographic, disability and macroeconomic projections, the added sophistication of a microsimulation model would appear to offer no greater accuracy in results.

In the following section, we detail the existing literature concerning relevant social insurance modelling in Australia as a means of making explicit the contribution sought in this paper.

2.2 Australian Social LTC Insurance Modelling Literature

The only paper to consider a social LTC insurance model for Australia is McCallum et al. (1998) who proposed a social insurance scheme for aged care. This 'Ensuring Quality of Later Life' (EQOLL) model is a univariate projection model which calculates the required contribution by participants in the Australian labour force aged 25 and over and earning in excess of $15,000 per annum to fund aged care requirements on a PAYG basis. Our study differs from McCallum et al. (1998) in the following manner:

1. McCallum et al. (1998) strictly consider 'aged care' whereas we consider LTC in general;
2. We consider a more general framework. We do not adhere to a strict PAYG funding model but rather an *n*-year roll forward reserving framework where short term reserves (typically 1 or 2 years) are held for the purposes of buffering adverse movements in income or expenditure. Note that our model could

conceivably be used to mimic a PAYG methodology by simply approximating a 'zero –year' reserve;
3. We use results for future LTC requirements and costs as estimated using a Markovian multiple state model as studied in Leung (2004a) as opposed to a univariate projection employed in McCallum et al. (1998);
4. We use different forecast methodologies for estimating future macroeconomic parameters;
5. We seek to present a range of scenarios for both contribution rates and reserve profiles based on a sensitivity analysis of forecast parameters in our model;
6. We consider a significantly longer projection horizon.

We believe that an n-year roll forward reserving framework is preferable to a PAYG structure (as per McCallum et al. (1998)) given that an n-year roll forward reserve provides both participant confidence in the scheme and prudential integrity of the fund. It is for this reason that we move away from the EQOLL type funding model towards the following framework.

2.3 Roll Forward Reserves

Nesbitt (1991) and Nesbitt et al. (1993,1994,1995,1996,1997) have developed a framework to calculate reserve funds for social insurance programs. Such models have subsequently been applied to social security programs by Beekman and Kabir (1997). The underlying concept of the n-year roll forward reserving methodology is the development of a reserve fund equivalent at the end of each year to the projected outflow of the fund for the following n years. Typically n is chosen to be small but may vary depending on policy aimed at balancing the degree of reserve fund build-up, participant confidence in the scheme and the need for government to have sufficient time to act in the event of adverse experience. The model allows for the calculation of contribution rates to maintain n-year roll forward reserves on a yearly roll-forward basis as well as m-year step-wise level contribution rates for a fixed term of m years.

In this paper, we calculate 1-year and 2-year roll forward reserve profiles for a social LTC insurance scheme in Australia and the associated contribution rates to maintain 1-year and 2-year reserves on a roll-forward basis. We also calculate 4-year step-wise level contribution rates. Much of our analysis, however, is devoted to projecting the income and outgo for year-by-year streams and the sensitivity of these projections to the ultimate reserve profiles and contribution rates. Moreover, the work on projecting future needs and costs of LTC in Australia has previously been undertaken in Leung (2004a).

3 Model Assumptions and Forecasting Macroeconomic Variables

The sensibility of the results of this model rely entirely on the reasonableness of the demographic, macroeconomic and chronic disability forecasts for Australia over the coming decades. We have considered at length the issue of demographic and chronic disability forecasts for Australia in Leung (2004a) which will be incorporated into this model. In addition, however, we require long-term forecasts of key macroeconomic variables including labour force participation (comprising people both employed and unemployed but available to work), unemployment rates, wages, interest rates and inflation. Models for forecasting assumptions for various social insurance programs are available in the literature (see, for example, Andrews and Beekman (1987), Frees et al. (1997) and Frees (1999)) but inevitably become less useful as the forecast horizon becomes long - which is the case here where we seek to project to 2050. Given the extreme difficulty of accurately forecasting in the long-run, we prefer to both analyse historical data on the relevant macroeconomic variables and survey relevant literature to determine reasonable long term 'scenarios', and subsequently analyse our model results with respect to sensitivities of these parameters. Note also that given the lack of adequate information at the individual level, we use aggregated data for our forecasts which will be described in the following sections.

We introduce in this section the following notation:

${}^{x}POP_k^M$:	projected male population aged x in the year $(k,k+1)$.
${}^{x}POP_k^F$:	projected female population aged x in the year $(k,k+1)$.
${}^{x}LFPR_k^M$:	projected labour force participation rate for males aged x in the year $(k,k+1)$.
${}^{x}LFPR_k^F$:	projected labour force participation rate for females aged x in the year $(k,k+1)$.
${}^{x}AYE_k^M$:	projected average yearly earnings for males aged x in the year $(k,k+1)$.
${}^{x}AYE_k^F$:	projected average yearly earnings for females aged x in the year $(k,k+1)$.
${}^{x}UR_k^M$:	projected unemployment rate for males aged x in the year $(k,k+1)$.
${}^{x}UR_k^F$:	projected unemployment rate for females aged x in the year $(k,k+1)$.

3.1 Forecasting Long-Run Participation and Income for the Scheme

Forecasting long-run participation in the scheme and subsequent income generated for the fund becomes a question of estimating the size of Australia's active future labour force and their respective salaries. We estimate the total taxable payroll in year t from which contributions may be levied by the relationship:

$$I_k = \sum_{i=M,F} \sum_{x} {}^{x}POP_k^i \times {}^{x}LFPR_k^i \times {}^{x}(1-UR_k^i) \times {}^{x}AYE_k^i \qquad (1)$$

We use estimates of the projected Australian population as contained in Leung (2004a), and our estimates for future labour force participation, unemployment and average yearly earnings are determined as follows.

Labour Force Participation

A wide range of methodologies may conceivably be implemented to forecast labour force participation rates in Australia. For instance, Frees (2003) estimates a modified seemingly unrelated regression (SUR) model to generate stochastic forecasts of labour force participation rates in the United States (US). As demonstrated in his paper, a significant advantage of this approach is that it allows the determination of prediction intervals, thus giving a range of reliability for the projections. An obvious drawback of this approach, however, is its reliance on adequate longitudinal data. An alternative methodology may be to generate forecasts based on a multiple state model of the labour market, which, where coupled with a population projection model, may provide adequate estimates of the future labour force. Carino-Abello et al. (2000) examine labour market dynamics using multinomial logit regressions and determine estimates of transition probabilities for labour market transitions underlying employment and unemployment patterns in Australia. Again, an obvious criticism of this approach is the absence of an explicit trend influence on labour force participation without understanding how transition probabilities in the labour market would change over time – which cannot directly be determined from such a model.

We therefore chose to employ a simple time-trend technique, consistent with the methodology used by the ABS in their published labour force projections for Australia (ABS 1999). Given that we would expect labour force participation to exhibit different patterns depending on age and sex, we chose to project labour force participation for sixteen age-by-sex groups using monthly participation rates for the period February 1978 to March 2004 sourced from ABS (1999) and described in Section 19 of ABS (2001). We use the methodologies proposed by Kennedy and Rossiter (1999) who projected the Australian labour force to 2016 using three basic methods for various age groups. They are:

1. *Constant rates* where the participation rate is extrapolated using the average participation rate calculated over the most recent ten year period. We used constant rates only for the highest age groups where we assume participation rates continue to remain stable.

2. *Linear trends* using the regression equation:

$$p_t = \alpha + \beta t + \varepsilon_t \qquad (2)$$

   where t is a linear time trend, p_t is the participation rate in time period t, ε_t is the residual in time period t and α and β are parameters estimated using ordinary least squares (OLS) regression. We used linear trend extrapolation only where the participation rates appeared to steadily increase or decline over time.

3. *Logistic trends* using the regression equation:

$$p_t = \frac{1}{\kappa + \alpha\beta^t} + \varepsilon_t \qquad (3)$$

where t is a linear time trend, p_t is the participation rate in time period t, ε_t is the residual in time period t and α,β and κ are parameters estimated using non-linear least squares (NLLS) regression. Note that for some age groups where projected male and female participation rates would cross over and diverge in the projected time horizon, simultaneous NLLS estimation for both male and female parameters was used such that the extrapolated trends converged to the same rate (as per Kennedy and Rossiter 1999).

Table 1 summarises the projection technique implemented for each age group.

Table 1: Sex and age-group labour force participation projection techniques

Age	Male	Female
15-19	Logistic	Linear
20-24	Logistic	Logistic
25-34	Logistic	Logistic
35-44	Logistic	Logistic
45-54	Logistic (Simultaneous)	Logistic (Simultaneous)
55-59	Logistic (Simultaneous)	Logistic (Simultaneous)
60-64	Logistic	Linear
65-69	Constant	Constant

The results of the projection for both male and female age groups are presented graphically in Figures 1(a) and 1(b) respectively. There are several key points to note. First, the primary age groups containing ages 20 to 59 show similar behaviour in the recent past, with male participation rates steadily declining in comparison to the gradually increasing female participation rates. Second, in comparison to Kennedy and Rossiter (1999) who only considered historical participation rates to 1993, it is interesting to note that the female participation rates show strong indications of tapering off over the period 1993 to 2004 – particularly in the age groups containing ages 20 to 44. For this reason, only 2 age groups, as compared to 4 in Kennedy and Rossiter (1999) required simultaneous NLLS estimation to ensure no cross over of participation rates. Third, the male 60 to 64 years age group remains a difficult age-group for trend analysis given the sharp declines experienced in the 1980s and subsequent reversal. Although we fit a logistic trend for this age-group, the results indicate a largely constant trend going forward. The 65 to 69 age group remains stable and a constant trend continues to be appropriate.

Figure 1(a): Actual and Projected Australian male labour force participation rates to 2051.

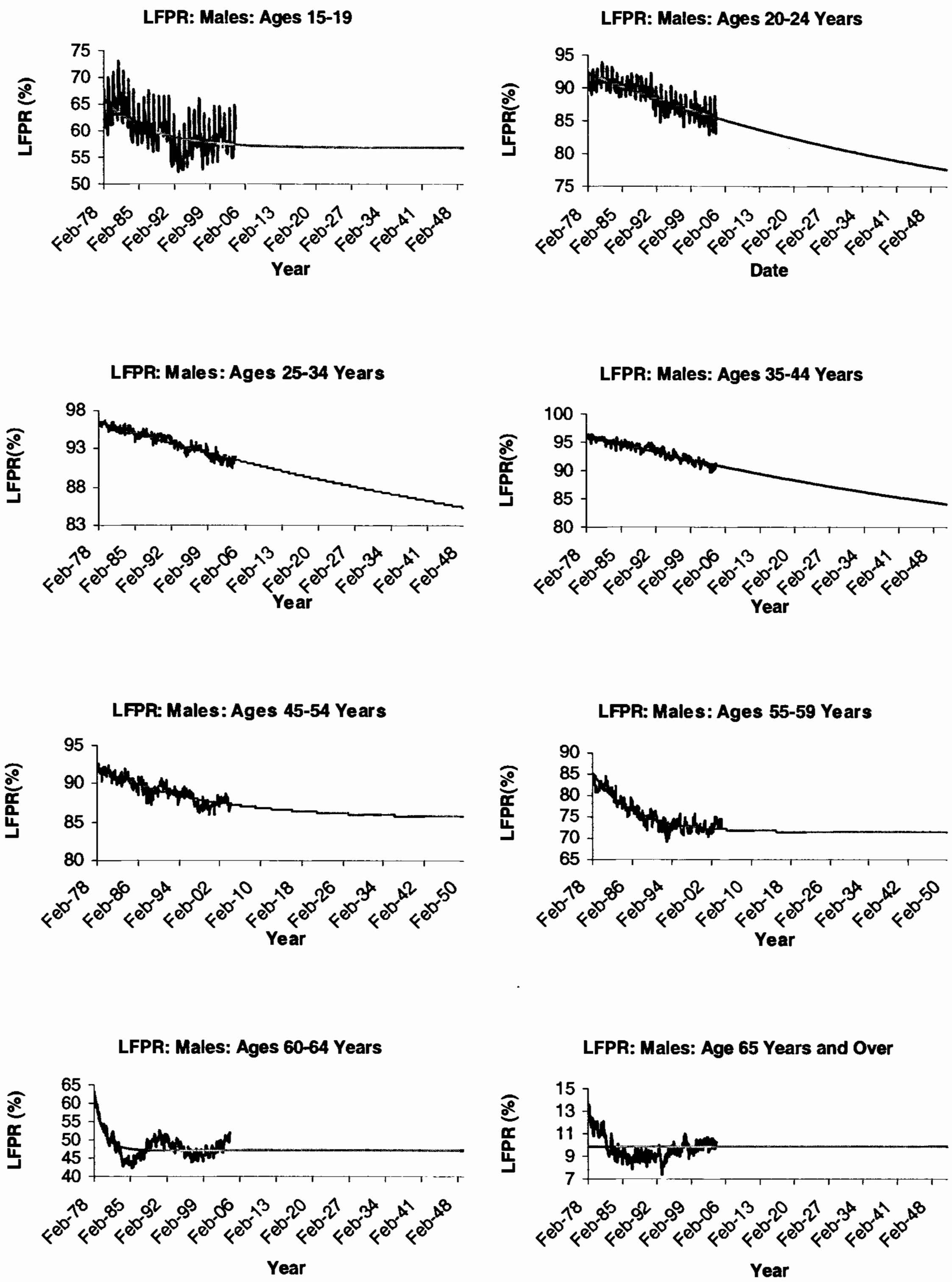
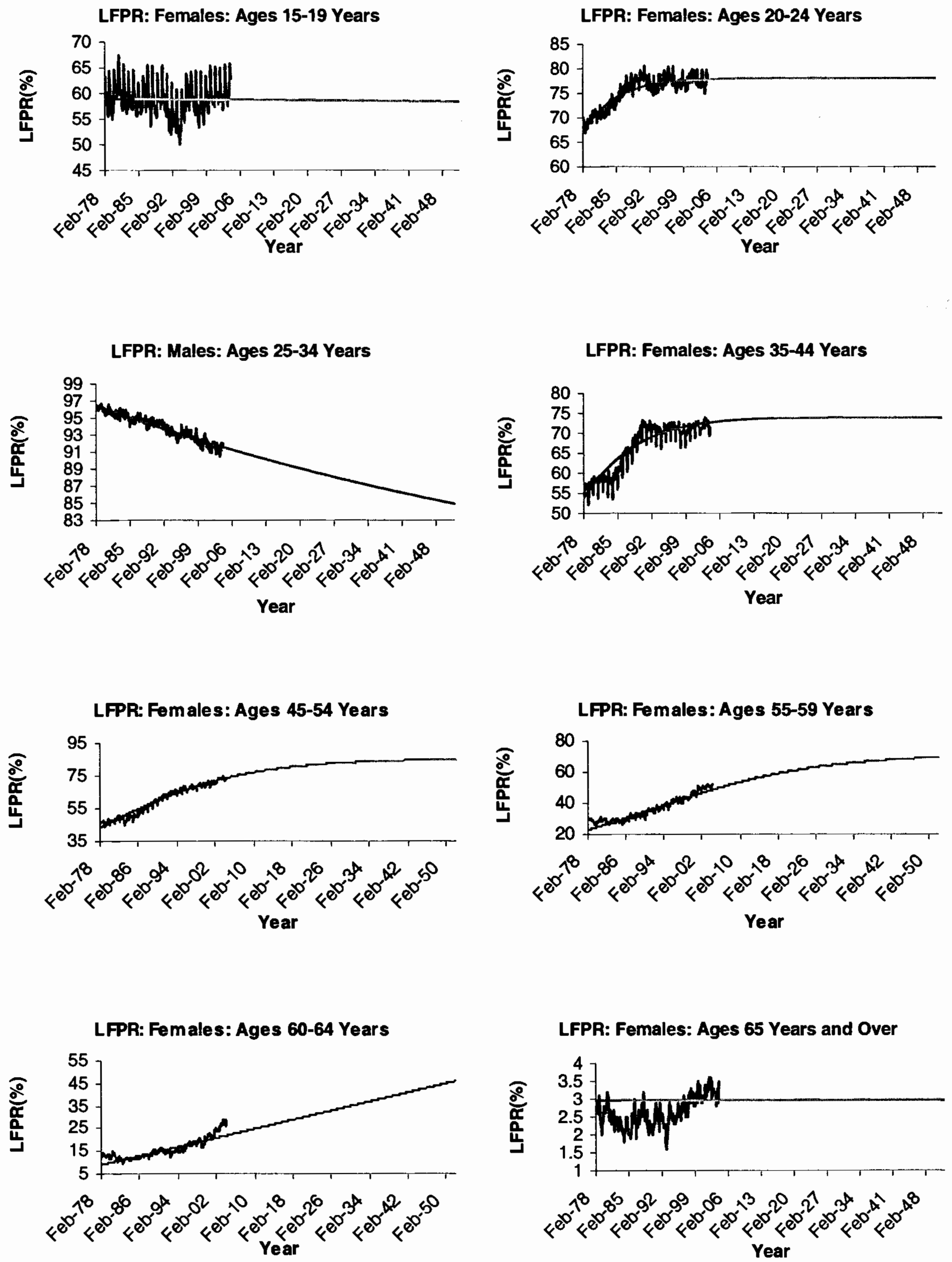


Figure 1(b): Actual and Projected Australian female labour force participation rates to 2051.



Average Yearly Earnings

Owing to the long-term nature of our projections, we assume that real wage increases follow the total factor productivity (TFP) growth of the economy. Although it is arguable that labour productivity growth is a more direct indicator of real wage increases (Plamondon et al. 2003), we assume, conservatively, that real wage growth is attributable to factors other than merely the quantity and quality of labour such as the level of capital in the economy. We therefore project average yearly earnings to 2050 for males and females by applying an estimated TFP growth rate to the current average yearly earnings as sourced from the ABS Survey of Average Weekly Earnings and discussed in Section 27 of ABS (2001). Note that, ideally, projections of salary distributions would be required to account for the differentiation of wages according to age and income groups (see, for example, Iyer 1999). We have chosen, however, not to account for salary distributions as we have come across no discernible evidence to suggest that the real wage increase for any particular age or income group would be affected by TFP growth rates more than any other age group in the long-term.

We estimate TFP growth by constructing a Tornqvist TFP Index (also known as the Divisa-Translog Index) as defined by Gollop and Jorgenson (1980) who studied productivity growth in the US. Subsequent applications of the Tornqvist TFP Index include Suardi (2000) for TFP growth in Singapore. Assuming a constant-returns-to-scale production function for Australia, the idea here is to approximate a discrete TFP growth rate over a given period as the difference between the successive logarithms of output, driven by the weighted average of the difference between the successive logarithms of capital and labour respectively. Weights are determined by the average value shares of capital and labour inputs contributing to output. This may be represented as:

$$\ln Q(t) - \ln Q(t-1) = \bar{\alpha}_K\left[\ln K(t) - \ln K(t-1)\right] + \bar{\alpha}_L\left[\ln L(t) - \ln L(t-1)\right] + \left[\ln TFP(t) - \ln TFP(t-1)\right] \qquad (4)$$

where *Q(t), K(t), L(t)* and *TFP(t)* represent output, capital input, labour input and total factor productivity in period *t*, with $\bar{\alpha}_K$ and $\bar{\alpha}_L$ being the value shares of capital and labour inputs averaged over periods *t* and *t-1* respectively. Rearranging in terms of the difference of successive logarithms of TFP gives the Tornqvist index of TFP growth. That is:

$$\ln TFP(t) - \ln TFP(t-1) = \ln \frac{Q(t)}{K(t)^{\bar{\alpha}_K} L(t)^{\bar{\alpha}_L}} - \ln \frac{Q(t-1)}{K(t-1)^{\bar{\alpha}_K} L(t-1)^{\bar{\alpha}_L}} \qquad (5)$$

We calculate the Tornqvist index of TFP growth for Australia over the period 1983 to 2002 using the following data sources.

1. A real GDP series for output was sourced from the ABS Treasury Model Database (TRYM), Table 05: TRYM.4.

2. A labour force series for labour input was sourced from the ABS Labour Force Statistics, Table LMLF-903: Aus.
3. A capital input series was constructed by considering gross fixed capital formation, net of consumption of fixed capital. A gross fixed capital formation series was sourced from the ABS National Accounts using a chain volume measure - Table 5204-91: Gross Fixed Capital Formation: Total Sectors: Total. A consumption of fixed capital series was sourced from the ABS national accounts using a chain volume measure - Table 5204-93: Consumption of Fixed Capital: Total.

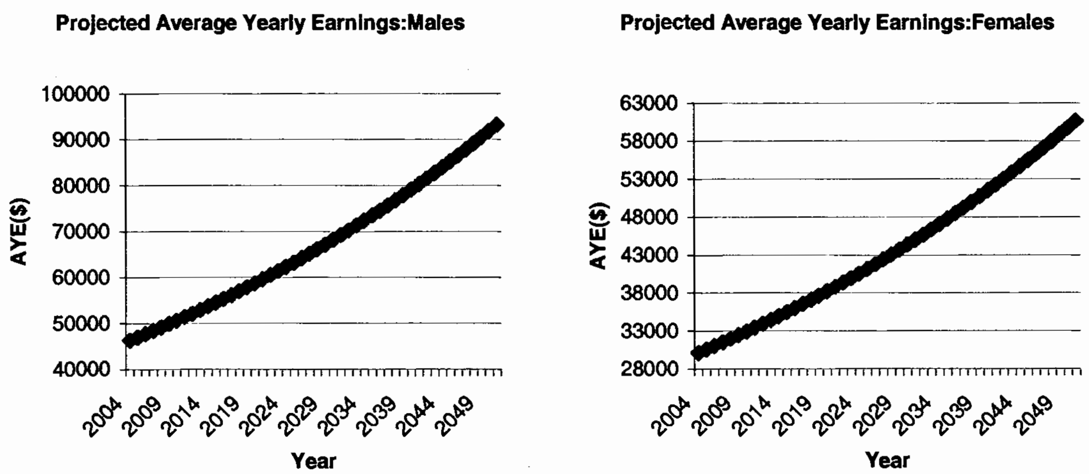
The average value share of capital was determined as the ratio of capital input to output over the period *t-1* to *t* and average value share of labour was the complement of this.

Our results indicate a mean TFP growth rate over the period 1983 to 2002 of 1.4% per year and a median TFP growth rate of 1.5% per year.

This is consistent with other studies undertaken on TFP growth in Australia. For instance, Parham (2002) estimates that TFP growth in the 1990s reached 1.8% per year compared to 0.7% per year as experienced in the 1980s. Similarly, Dawkins and Rogers (1998) report ABS measures of TFP growth between 1988 to 1996 to be 1.2% per year.

Applying a TFP growth rate of 1.5% per year to current average yearly earnings for both males and females provides a series of forecast average yearly earnings as presented in Figure 2(a) and Figure 2(b).

Figure 2(a)(b): Projected average yearly earnings- males and females.



Several key points should be mentioned. First, given the nature of our assumption here, higher current average yearly earnings for males results in a consistently higher average yearly earnings for males compared to females. Ongoing labour market reform may see the eventual convergence of male and female salaries, although we refrain here from speculating as to when and to what extent this will occur. Moreover, we have assumed that reasonably strong TFP growth of 1.5% per year will continue over the projection period. Whether Australia can sustain strong productivity growth over the long-run is open to speculation (Gruen 2001).

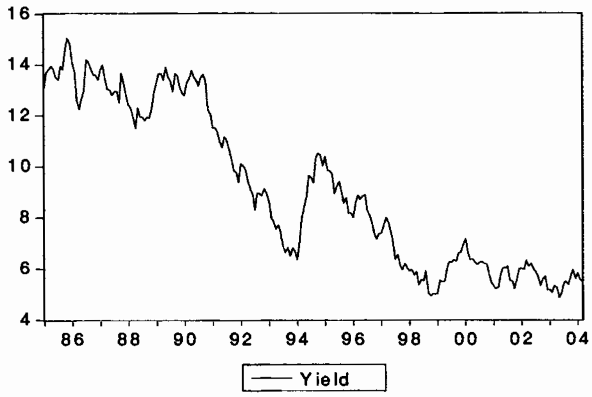
Unemployment Rate

Frees (1999) and Frees et al. (1997) demonstrate the usefulness of univariate time series forecasting techniques to forecast unemployment rates in the short-run. In the long-run, however, estimates of the unemployment rate are subject to a myriad of influences – particularly inflation. The Department of Treasury (2002), in their Intergenerational Report, consider the non-accelerating inflation rate of unemployment (NAIRU) as an estimate for long-term unemployment. However, determining the exact level of the NAIRU is difficult and likely to shift over time due to structural changes in the economy or labour market reforms. For example, Gruen et al. (1999) estimated the NAIRU to be between 5.5 % and 7.0% in 1997. We implement a long-run unemployment rate of 5.0% for all our projection period. Our choice is motivated solely by consistency with the Department of Treasury (2002).

3.2 Long-run Interest Rate and Inflation Forecasting

We present in this section evidence from some diagnostic tests we performed on historical monthly yields on Commonwealth 10 Year Treasury Bonds sourced from the RBA Bulletin Database (Table F.02.1: Capital Market Yields: Govt. Bonds) suggesting that no reasonable econometric time series structure, at least in a univariate setting, is suitable for this series and is thus unlikely to yield accurate forecasts. The general framework we considered was an Autoregressive Moving Average (ARMA) structure (see, for example, Frees et al. 1997). These models and associated tests are well established and discussed authoritatively in Hamilton (1994) and Enders (1995). Consider firstly Figure 3, which plots the monthly Commonwealth 10 Year Treasury Bond yield from January 1985 to March 2004.

Figure 3: Monthly Commonwealth 10 Year Treasury Bond Yields: January 1985 – March 2004.



The obvious downward trend indicates that the series is non-stationary. If we let y_t denote the yield from a 10-year Commonwealth treasury bond in year t, we may test for stationarity (which we require for univariate modelling) by estimating the Augmented Dickey-Fuller (ADF) equation, allowing for both an intercept and time trend (Hamilton 1994). The relevant hypothesis test here is a null hypothesis of non-stationarity and an alternative hypothesis of stationarity.

We also test for stationarity using the Kwiatkowski-Phillips-Schmidt-Schin (KPSS) test (Kwiatowski et al. 1992) where the series is assumed to be stationary under the null hypothesis.

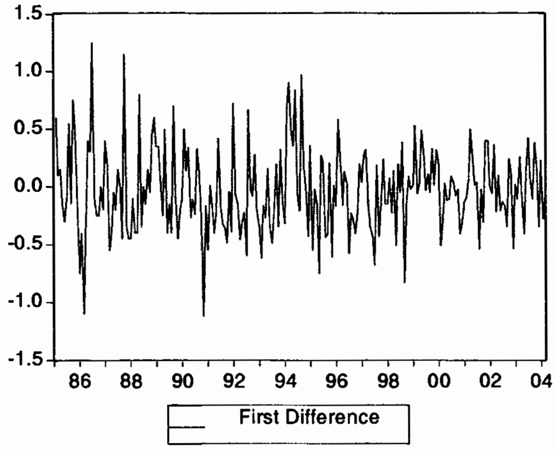
The results of our unit-root tests performed on Eviews and contained in Table 2 confirms our visual indications of non-stationarity from Figure 3.

Table 2: Unit Root Testing: Level Data

Diagnostic Test			
Augmented Dickey-Fuller Test (ADF)	t-statistic		-2.416982
	p-value		0.3698
	Critical Values		
		1%	-3.998457
		5%	-3.429484
		10%	-3.138243
Kwiatkowski-Phillips-Schmidt-Schin Test (KPSS)	LM-statistic		0.149078
	Asymptotic Critical Values		
		1%	0.216
		5%	0.146
		10%	0.119

Both the ADF and KPSS tests (at the 5% level) indicate that the series is non-stationary. We therefore consider the first difference of the series as illustrated in Figure 4.

Figure 4: First order difference of monthly Commonwealth 10 Year Treasury Bond Yields: January 1985 – March 2004.



We confirm that the first difference of the series, $\Delta y_t = y_t - y_{t-1}$, is stationary by performing the ADF and KPSS test on Δy_t.

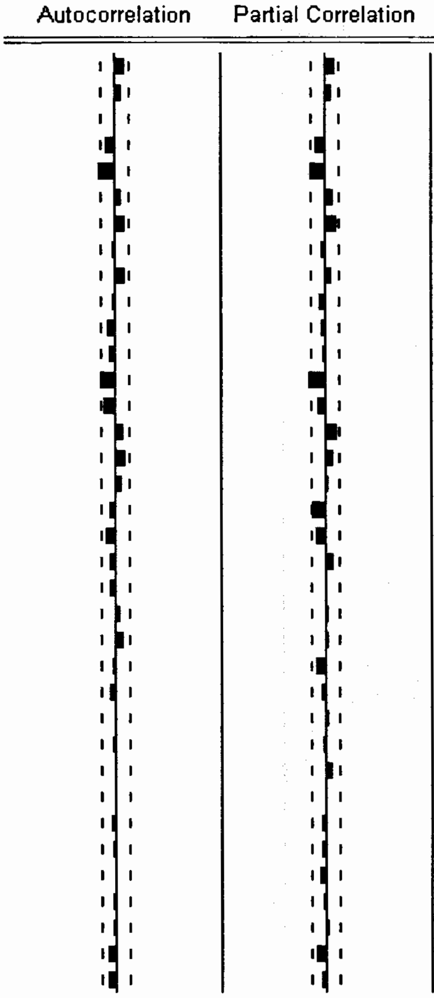
Table 3: Unit Root Testing: First Order Difference

Diagnostic Test			
Augmented Dickey-Fuller Test (ADF)	t-statistic		-13.84828
	p-value		0.0000
	Critical Values		
		1%	-3.458845
		5%	-2.873974
		10%	-2.573472
Kwiatkowski-Phillips-Schmidt-Schin Test (KPSS)	LM-statistic		0.051011
	Asymptotic Critical Values		
		1%	0.739000
		5%	0.463000
		10%	0.347000

The results of both the ADF and KPSS tests in Table 3 strongly indicate that the first difference of the series is stationary and hence the series is integrated of order one.

We now consider the correllogram of the first difference as presented in Figure 5 and the results of the Box-Q tests of the first difference in Table 4. We note, however, that the resulting correlogram does not suggest any AR or MA patterns and the Box-Q tests indicate no significantly autocorellated lags at the 5% level.

Figure 5 and Table 4: Correlogram and Box-Q statistics for first difference.



Lag	AC	PAC	Q-Stat	Prob
1	0.090	0.090	1.9076	0.167
2	0.054	0.047	2.6026	0.272
3	0.004	-0.005	2.6065	0.456
4	-0.082	-0.085	4.1959	0.380
5	-0.151	-0.139	9.5763	0.088
6	0.041	0.076	9.9820	0.125
7	0.093	0.104	12.044	0.099
8	-0.010	-0.038	12.066	0.148
9	0.087	0.056	13.877	0.127
10	-0.024	-0.050	14.015	0.172
11	-0.065	-0.038	15.036	0.181
12	-0.046	-0.012	15.562	0.212
13	-0.146	-0.149	20.806	0.077
14	-0.111	-0.079	23.862	0.048
15	0.080	0.103	25.461	0.044
16	0.088	0.067	27.388	0.037
17	0.051	0.021	28.031	0.045
18	-0.050	-0.130	28.649	0.053
19	-0.087	-0.090	30.575	0.045
20	-0.050	0.061	31.212	0.052
21	-0.051	-0.004	31.873	0.060
22	0.028	0.019	32.074	0.076
23	0.071	0.025	33.384	0.075
24	-0.014	-0.085	33.438	0.095
25	-0.041	-0.037	33.879	0.111
26	0.007	0.011	33.894	0.138
27	-0.018	-0.011	33.975	0.167
28	0.001	0.049	33.975	0.202
29	0.000	-0.006	33.975	0.240
30	-0.026	-0.038	34.154	0.275
31	-0.021	-0.039	34.275	0.313
32	0.006	-0.054	34.286	0.359
33	-0.021	-0.009	34.404	0.400
34	-0.019	0.017	34.499	0.444
35	-0.078	-0.087	36.145	0.415
36	-0.065	-0.039	37.314	0.408

The absence of a significant autocorrelation or partial correlation for Δy_t at the 5% significance level indicates that we are unable to fit an ARMA structure to the series. These results therefore indicate that the underlying yields from 10-year Commonwealth Treasury bonds follow a random walk process. As such, past movements of y_t cannot be used to predict future movements. Concededly, attempting to forecast interest rates by employing a univariate framework is difficult, attributable in part, to the unaccountable number of influences underlying interest rate behaviour. That is, in forecasting interest rates, one may consider the impact of factors such as inflation forecasts, monetary growth rates or even demographic factors (see McMillan 1988) by employing multivariate time series techniques. Given that we are attempting to forecast interest rates so far into the future, we believe that even multivariate time series techniques would not result in superior forecasts over such a long-term (see, for example, Bidarkota 1998).

Given these difficulties, a vast amount of economic literature requiring long-term forecasts of interest rates relies on a hypothesised equilibrium 'world interest rate', *r*, set at a particular level and modified systematically for sensitivity analysis. We do the same here, and use the same value chosen by Barro and Sala-I-Martin (1995) of 6%.

Despite ongoing studies of sophisticated time-series models for modelling inflation in Australia (eg De Brouwer and Ericsson 1998), similar difficulties as discussed in forecasting interest rates over such a long term are inherent in inflation forecasting. Given, however, that the Reserve Bank of Australia (RBA) have set an inflation target of between 2% and 3% and have consistently maintained this level for the past decade (Stevens 2003), we set the level of inflation in our model to 2.5% for the duration of the projection period.

3.3 LTC Cost Projections

We use the results of the Series D LTC cost projections as determined in Leung (2004a, Section 9) where aggregate expenditure in a given base year was used to establish an average real expenditure per person (no disaggregation between sex and institutional or non-institutional care), and inflated in line with the projected number of persons requiring LTC as determined by the multiple state projection model.

3.4 Population Projection

Similarly, as with Leung (2004a), the projection assumptions in this paper are in line with the ABS Series II (ABS 2000a) assumptions aside from mortality improvement which is detailed in Leung (2004a, Section 6).

4 Roll Forward Reserve Calculations

Also known as 'partial reserve funding', *n*-year roll forward reserve funding is characterised by the development of a reserve fund equivalent at the end of each year to the projected outgo of the fund for the subsequent *n* years. Thus, when *n* approaches zero, the financing is considered PAYG. Emphasis here is placed on building and holding only the necessary reserve funds to both maintain confidence in the integrity of the fund and to provide sufficient time for administrators to implement adjustments if the experience so requires. For a social LTC insurance scheme, typical of social security systems, *n* may well be less than 5 (see Nesbitt et al. 1994). We therefore chose to consider only the cases when *n* is equal to 1 or 2. Extending consideration to larger *n* is straightforward.

Again note that we are assuming here an Australian social LTC insurance scheme to be administered by the Commonwealth where benefits are provided to any person, irrespective of age, requiring LTC, funded from contributions based on a percentage of yearly tax assessable income by all employed persons, irrespective of age or income level, in the population.

4.1 1-Year and 2-Year Roll Forward Reserve Profiles

Using the notation of Nesbitt (1991), Nesbitt et al. (1993, 1994, 1995, 1996, 1997) and Beekman and Kabir (1997) we define the following notation:

O_k : outflow of LTC benefits over calendar year k to $k+1$.

${}_nA_k$: amount of reserve fund required at the beginning of calendar year k under n-year roll forward reserves.

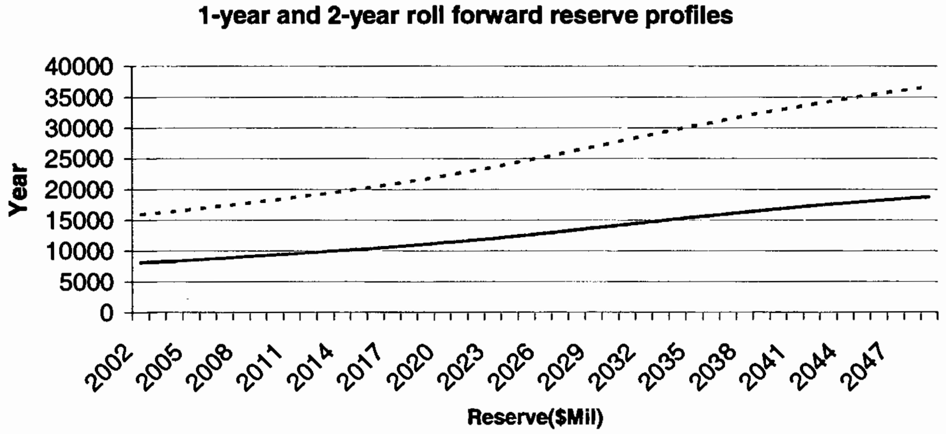
Using our earlier LTC cost projections in Leung (2004a), O_k is merely synonymous with $\overline{LTC_t}$ in Section 9 and ${}_nA_k$ is related to O_k by the relationship:

$$ {}_nA_k = O_k + O_{k+1}(1+r_k)^{-1} + O_{k+2}(1+r_k)^{-1}(1+r_{k+1})^{-1} + \dots + O_{k+n}\left[(1+r_k)^{-1} \times \dots \times (1+r_{k+n-1})^{-1}\right] $$

$$ = O_k + \sum_{j=1}^{n} O_{k+j} \prod_{h=0}^{j-1} (1+r_{k+h})^{-1} \qquad (6) $$

where r_k refers to the prevailing interest rate over calendar year k to $k+1$. Table 5 and Figure 6 present the 1-Year and 2-Year roll forward reserve profiles for an Australian social LTC insurance scheme in current dollars.

Figure 6: ${}_1A_k$ and ${}_2A_k$ for an Australian social LTC insurance fund in current dollars.



The behaviour of the 1-year and 2-year reserves mimics that of the old-age, survivors and disability insurance (OASDI) roll forward reserve funds studied by Nesbitt et al. (1994). The graphs clearly indicate the exponential type growth of the required reserve fund with the rate of growth varying directly with the magnitude of n. What we are particularly concerned with is not necessarily the build up of the roll forward reserve but rather the contribution rates necessary to sustain such reserve profiles. We consider this in the following section.

Table 5: ${}_1A_k$ and ${}_2A_k$ for an Australian social LTC insurance fund in current dollars.

Year	${}_1A_k$	${}_2A_k$
2002	8146	16141
2003	8475	16807
2004	8832	17522
2005	9212	18280
2006	9612	19072
2007	10028	19900
2008	10465	20768
2009	10922	21675
2010	11398	22621
2011	11896	23609
2012	12416	24642
2013	12959	25722
2014	13528	26853
2015	14125	28042
2016	14752	29293
2017	15413	30613
2018	16111	32006
2019	16848	33478
2020	17627	35032
2021	18449	36672
2022	19316	38400
2023	20229	40220
2024	21190	42135
2025	22201	44148
2026	23263	46259
2027	24376	48470
2028	25540	50779
2029	26754	53183
2030	28015	55679
2031	29323	58261
2032	30674	60925
2033	32066	63669
2034	33499	66491
2035	34971	69392
2036	36485	72373
2037	38041	75436
2038	39639	78583
2039	41281	81815
2040	42966	85131
2041	44695	88531
2042	46466	92011
2043	48278	95571
2044	50130	99207
2045	52022	102920
2046	53953	106711
2047	55924	110580
2048	57936	114532
2049	59991	118569
2050	62092	

4.2 1-Year and 2-Year Roll Forward Funding Contribution Rates

Here, we estimate contribution rates to be levied on the taxable income of the projected future Australian workforce in order to maintain 1-year and 2-year roll forward reserves. Again, using the notation of Nesbitt (1991), Nesbitt et al. (1993, 1994, 1995, 1996, 1997) and Beekman and Kabir (1997) we further define:

${}_nI_k$: required fund income, excluding interest, in calendar year k to $k+1$ to maintain an n-year roll forward reserve;

W_k: projected total Australian taxable payroll in calendar year k to $k+1$;

${}_n\theta_k$: required contribution rate of taxable income in calendar year k to $k+1$ to maintain an n-year roll forward reserve.

Now, assuming reserves are held at the start of year k to cover expenditure in year k, $k+1$, ..., $k+n-1$, and ${}_nI_k$ is the required income at the start of calendar year k to $k+1$ to maintain an n-year roll forward reserve and provide O_{k+n} at the start of year $k+n$, then:

$$\begin{aligned} {}_nI_k &= O_{k+n}\left[(1+r_k)^{-1}\times(1+r_{k+1})^{-1}\times\ldots\times(1+r_{k+n-1})^{-1}\right] \\ &= O_{k+n}\prod_{h=0}^{n-1}(1+r_{k+h})^{-1} \end{aligned} \qquad (7.7)$$

Furthermore, total national taxable payroll may be approximated as:

$$W_k = \sum_{i=M,F}\left[\sum_x {}^xPOP_k^i\times {}^xLFPR_k^i\times {}^xAYE_k^i\times(1-{}^xUR_k^i)\right] \qquad (7.8)$$

Therefore, the contribution rate to maintain n-year roll forward reserves is:

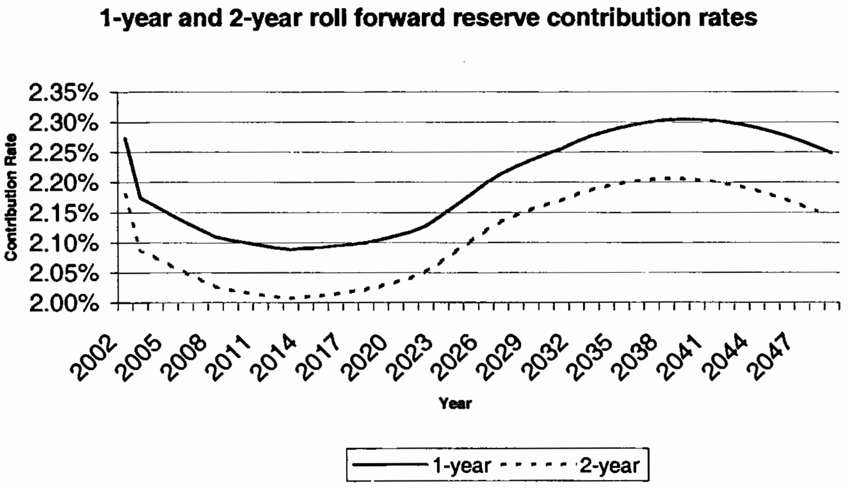
$${}_n\theta_k = \frac{{}_nI_k}{W_k} \qquad (7.9)$$

We present contribution rates to maintain 1-year and 2-year roll forward reserves in Table 6 and Figure 7.

Table 6: ${}_1\theta_k$ and ${}_2\theta_k$ for an Australian social LTC insurance fund.

Year	${}_1\theta_k$	${}_2\theta_k$
2002	2.2735%	2.1806%
2003	2.1748%	2.0877%
2004	2.1612%	2.0756%
2005	2.1479%	2.0624%
2006	2.1345%	2.0502%
2007	2.1219%	2.0382%
2008	2.1097%	2.0265%
2009	2.1044%	2.0215%
2010	2.1001%	2.0174%
2011	2.0959%	2.0135%
2012	2.0919%	2.0099%
2013	2.0894%	2.0079%
2014	2.0907%	2.0097%
2015	2.0920%	2.0118%
2016	2.0942%	2.0147%
2017	2.0972%	2.0186%
2018	2.1000%	2.0221%
2019	2.1053%	2.0280%
2020	2.1112%	2.0344%
2021	2.1180%	2.0415%
2022	2.1282%	2.0518%
2023	2.1445%	2.0679%
2024	2.1618%	2.0849%
2025	2.1800%	2.1024%
2026	2.1984%	2.1200%
2027	2.2143%	2.1349%
2028	2.2263%	2.1457%
2029	2.2371%	2.1551%
2030	2.2469%	2.1633%
2031	2.2558%	2.1704%
2032	2.2671%	2.1798%
2033	2.2772%	2.1880%
2034	2.2849%	2.1940%
2035	2.2913%	2.1988%
2036	2.2965%	2.2025%
2037	2.3006%	2.2051%
2038	2.3036%	2.2068%
2039	2.3044%	2.2063%
2040	2.3041%	2.2047%
2041	2.3028%	2.2021%
2042	2.3002%	2.1983%
2043	2.2965%	2.1934%
2044	2.2913%	2.1872%
2045	2.2849%	2.1798%
2046	2.2773%	2.1714%
2047	2.2688%	2.1622%
2048	2.2595%	2.1525%
2049	2.2491%	

Figure 7: Graph of $_1\theta_k$ and $_2\theta_k$ for an Australian social LTC insurance fund.



There are several key points to note. First, the results generally indicate that over the period 2002 to 2050, a contribution rate of between 2.00% and 2.35% of the assessable income of the Australian labour force is required to maintain either 1-year or 2-year roll forward reserves for a social LTC insurance fund. Second, the shape of the graph mimics the OASDI contribution rates as presented by Nesbitt et al. (1994). This is unsurprising given the strong similarities between OASDI and LTC utilisation patterns. The curvature of the graph is explained firstly by an initially increasing national taxable payroll prior to the retirement of the baby-boom generation driving contribution rates down, followed by a sharp increase in contribution rates owing to the increasing LTC utilisation requirements of the ageing baby-boom population, followed by steadily decreasing contribution rates as a result of the gradual death of the baby-boom generation. We would then expect a stabilisation of the contribution rate around an equilibrium level. Our projection horizon, however, was not sufficiently long to illustrate this. Finally, the contribution rate for 2-year roll forward reserves is uniformly lower than the 1-year roll forward contribution rate. This is attributable to greater interest income being earned on larger reserve funds.

We can compare the results of this model with the EQOLL model by McCallum et al. (1998) who employ an alternative, independent methodology. Table 7 presents a comparison of contribution rate requirements under this model and the EQOLL model up to 2011 (the projection horizon of the EQOLL model). Note that we are considering the EQOLL model result for aged care costs as a percentage of taxable income.

Table 7: ${}_1\theta_k$ and ${}_2\theta_k$ vs EQOLL model contribution rates.

Year	${}_1\theta_k$	${}_2\theta_k$	EQOLL
2002	2.2735%	2.1806%	3.24%
2003	2.1748%	2.0877%	3.24%
2004	2.1612%	2.0756%	3.24%
2005	2.1479%	2.0624%	3.24%
2006	2.1345%	2.0502%	3.32%
2007	2.1219%	2.0382%	3.36%
2008	2.1097%	2.0265%	3.36%
2009	2.1044%	2.0215%	3.36%
2010	2.1001%	2.0174%	3.36%
2011	2.0959%	2.0135%	3.39%

Note that the contribution rates under the n-year roll forward reserve model are uniformly lower than the contribution rates required under the EQOLL model. This is attributable to two main reasons. First, the EQOLL model is a PAYG funding methodology characterised by the absence of a reserve. As such, contributions do not accumulate and future outgo cannot be offset by interest income from the reserve fund. Second, the EQOLL model restricts the number of contributors to the scheme only to persons aged 25 and over and earning in excess of $15,000 per annum. We make no such restriction in our model.

Overall, our results appear reasonably consistent with the EQOLL model.

4.3 Step-Wise Level Percentage Contribution Rates

The above contribution rates have been calculated on the assumption that they may be adjusted on a yearly basis. This has obvious practical limitations from an administrative viewpoint. We make a straightforward extension to our results here by calculating level percentage contribution rates for m-year terms when $n=1$. That is, we compute contribution rates that are fixed for a term of m years as opposed to being recalculated annually. The case for when $n=2$ or higher, is subsequently straightforward and not illustrated here.

From Nesbitt et al. (1995), we can define an m-year level percentage contribution rate as:

$$
{}_1^m\theta = \frac{O_{k+1}\left[(1+r_k)^{-1}\right] + O_{k+2}\left[(1+r_k)^{-1}\times(1+r_{k+1})^{-1}\right] + \ldots + O_{k+m}\left[(1+r_k)^{-1}\times\ldots\times(1+r_{k+m-1})^{-1}\right]}{W_k + W_{k+1}\left[(1+r_k)^{-1}\right] + \ldots + W_{k+m}\left[(1+r_k)^{-1}\times\ldots\times(1+r_{k+m})^{-1}\right]}
$$

$$
= \frac{\sum_{j=1}^{m} O_{k+j}\prod_{h=0}^{m-1}(1+r_{k+h})^{-1}}{W_k + \sum_{j=1}^{m} W_{k+j}\prod_{h=0}^{j}(1+r_{k+h})^{-1}} \qquad (10)
$$

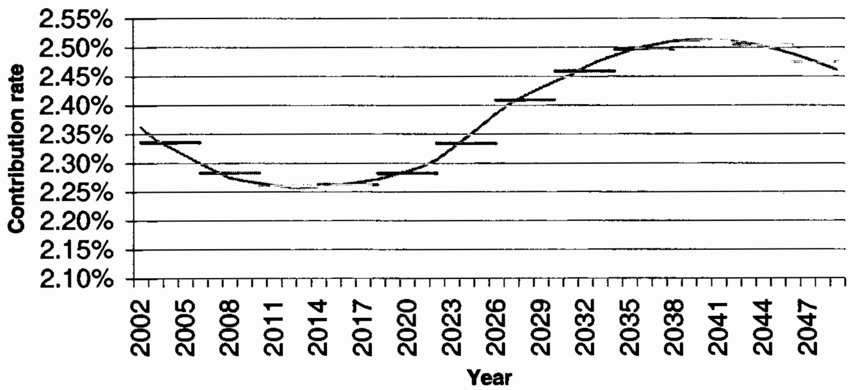
We illustrate this in Table 8 by presenting 4-year level percentage contribution rates necessary to maintain a 1-year roll forward reserve.

Table 8: 4-year level percentage contribution rates where $n = 1$.

Year	${}_1^4\theta$
2002 - 2006	2.3365%
2006 - 2010	2.2834%
2010 - 2014	2.2614%
2014 - 2018	2.2636%
2018 - 2022	2.2831%
2022 - 2026	2.3348%
2026 - 2030	2.4094%
2030 - 2034	2.4593%
2034 - 2038	2.4974%
2038 - 2042	2.5125%
2042 - 2046	2.5047%

As illustrated in Figure 8, a problem with m-year level percentage contribution rates is that junction points are not smooth.

Figure 8: Graph of ${}_1^4\theta$ compared to ${}_1\theta_k$



As such, there would appear to be minimal practical improvement over calculating contribution rates on a per annum basis unless the term m was chosen to be sufficiently large. This, however, would not be ideal in the present circumstances given the magnitude of the benefits provided and the need to flexibly manage fund income in the face of adverse experience. We would suggest against the use of an m-year level percentage contribution rate and advocate simply buffering annually calculated contribution rates with a loading factor to achieve smoothness.

5 Sensitivity Analsysis

Given the lengthy time horizon of our projections, we sought to examine the sensitivity of our results to several key macroeconomic variables in our model. Here, we present results for ${}_1\theta_k$ and ${}_2\theta_k$ after systematic changes in projected (1) labour force participation rates; (2) unemployment rates; (3) TFP growth rates; (4) LTC utilisation; and (5) interest rates.

5.1 Labour Force Participation Rates

We considered uniform percentage increases and decreases to the LFPR for each age group. Note that we have assumed that any percentage increase or decrease in LFPR will affect every age group similarly. The scenarios considered are:

1. Uniform 10% increase in ${}^xLFPR_k^M$ and ${}^xLFPR_k^F$.
2. Uniform 5% increase in ${}^xLFPR_k^M$ and ${}^xLFPR_k^F$.
3. Uniform 2.5% increase in ${}^xLFPR_k^M$ and ${}^xLFPR_k^F$.
4. Uniform 10% decrease in ${}^xLFPR_k^M$ and ${}^xLFPR_k^F$.
5. Uniform 5% decrease in ${}^xLFPR_k^M$ and ${}^xLFPR_k^F$.
6. Uniform 2.5% decrease in ${}^xLFPR_k^M$ and ${}^xLFPR_k^F$.

Figure 9 shows the results of these scenarios as compared to the original estimate as determined in Section 3.1.

5.2 Unemployment

We have used throughout this paper a long-run NAIRU of 5.0% for the entire projection period - chosen solely for consistency with the Intergenerational Report (Department of Treasury 2002). We consider both a uniform increase and decrease to the NAIRU for both males and females. The scenarios considered here are both ${}^xUR_k^M$ and ${}^xUR_k^F$ (NAIRU) being equal to 4% and 8%. Figure 10 shows the results of these scenarios as compared to the original NAIRU of 5.0%.

5.3 TFP Growth

TFP growth will directly affect average yearly earnings for both males and females and consequently income to the fund. We consider both a uniform increase and decrease to the TFP growth of the Australian economy. The scenarios considered here are TFP growth rates at 1.0%, 1.25%, 1.75% and 2.0 % respectively. Figure 11 shows the results of these scenarios as compared to the original TFP growth rate of 1.5%.

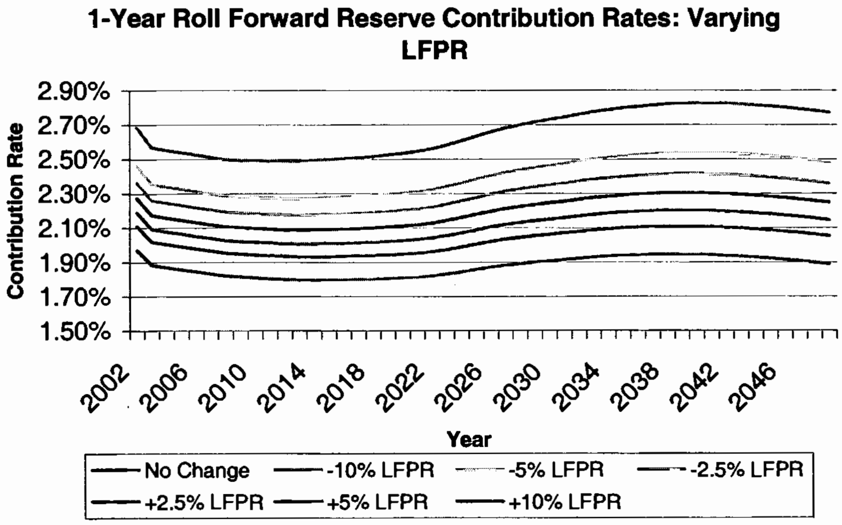
5.4 LTC Utilisation

Throughout this paper, LTC utilisation has been assumed to follow the assumptions of Series D in Leung (2004a). It is conceivable that future advances in medical care, particularly those relating to the treatment of chronic care, may reduce the incidence of chronic disability and thus reduce LTC utilisation. As such, we re-consider our results using Series A, Series B and Series C from Leung (2004a), reflecting assumptions of disability improvement in the future. Figure 12 shows the results of these scenarios as compared to the original Series D assumption.

5.5 Interest Rates

We have relied in our model on a hypothesised equilibrium 'world interest rate', *r*, set at a value chosen by Barro and Sala-I-Martin (1995) of 6.0%. We consider both increased and decreased equilibrium 'world interest rates' prevailing for the Australian economy over the coming decades. The scenarios considered here are interest rates at 2.0%, 4.0%, 8.0% and 10.0 % respectively. Figure 13 shows the results of these scenarios as compared to the original prevailing interest rate of 6.0%.

Figure 9: Sensitivity of $_1\theta_k$ and $_2\theta_k$ to uniform increases and decreases to projected LFPR.



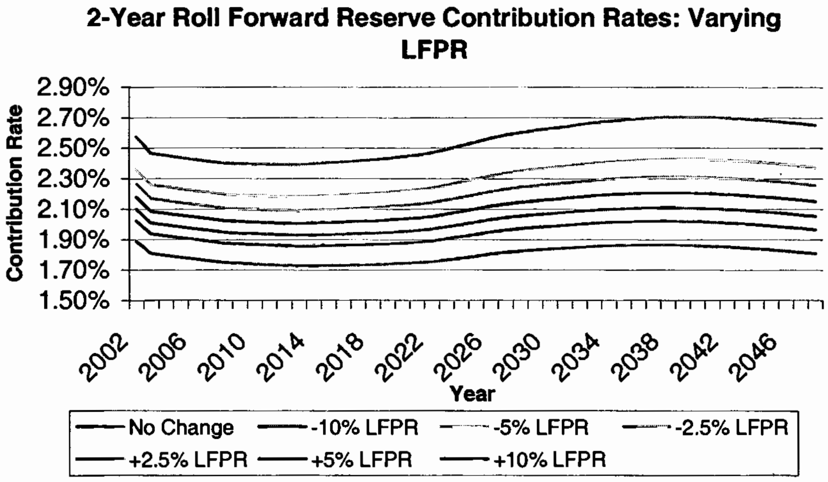
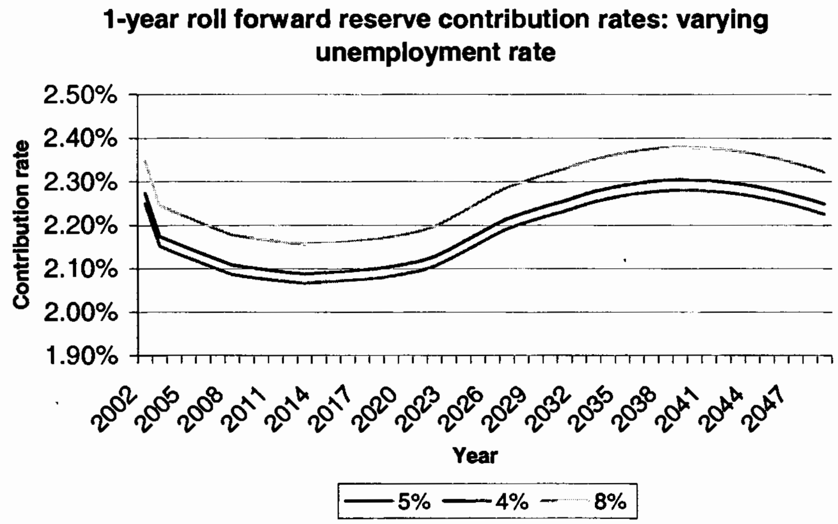


Figure 10: Sensitivity of $_1\theta_k$ and $_2\theta_k$ to uniform increases and decreases to the NAIRU.



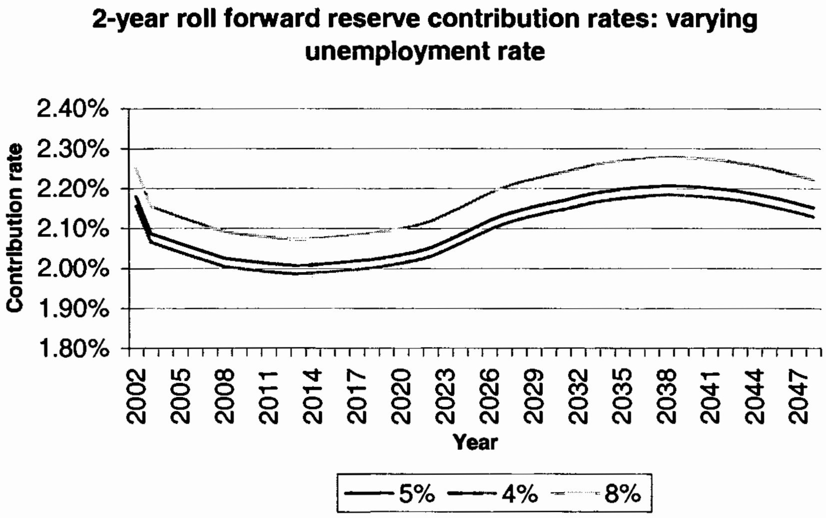
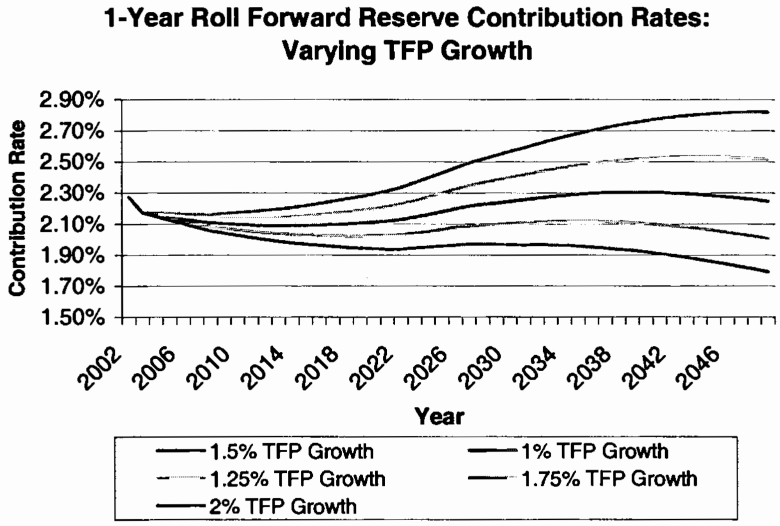


Figure 11: Sensitivity of ${}_1\theta_k$ and ${}_2\theta_k$ to increases in the TFP growth rate.



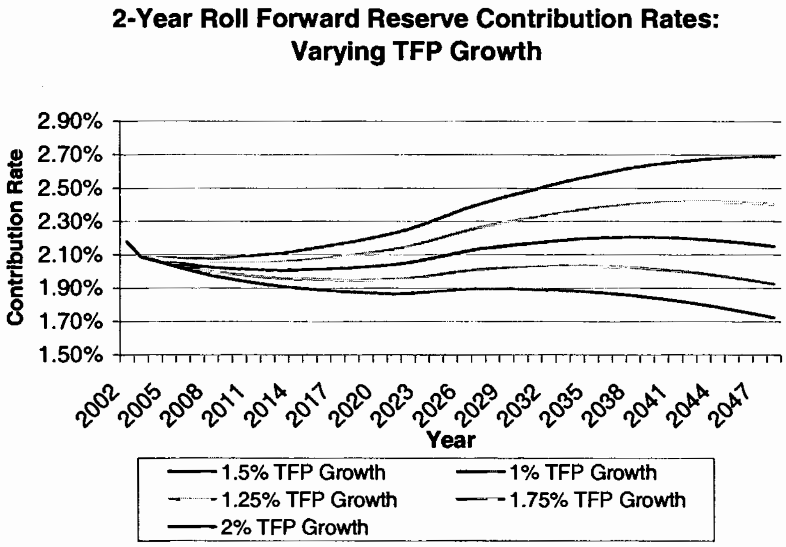
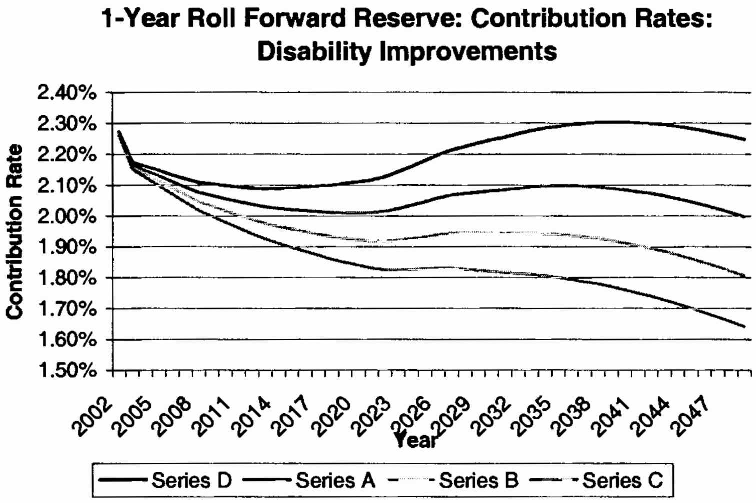


Figure 12: Sensitivity of $_{1}\theta_{k}$ and $_{2}\theta_{k}$ to reduced LTC utilisation.



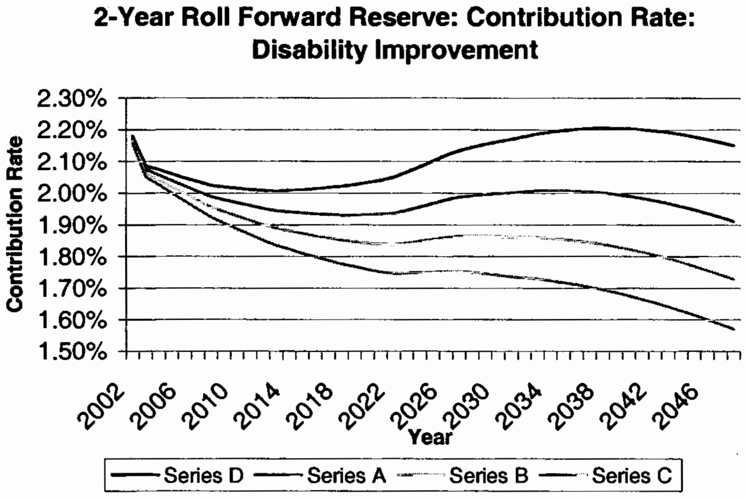
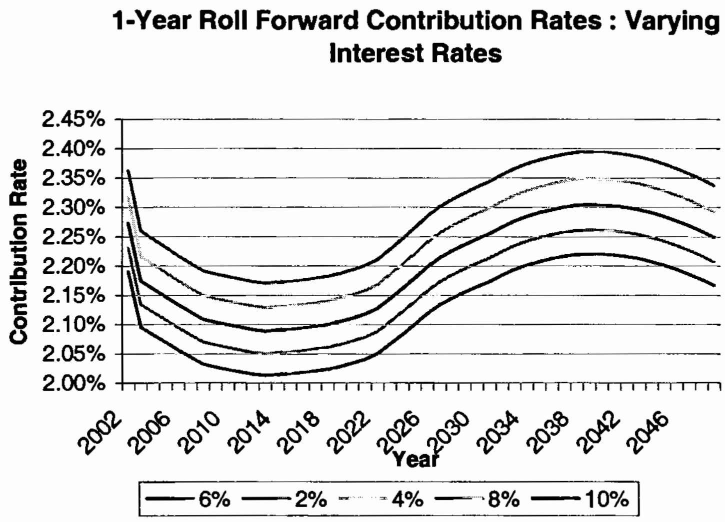
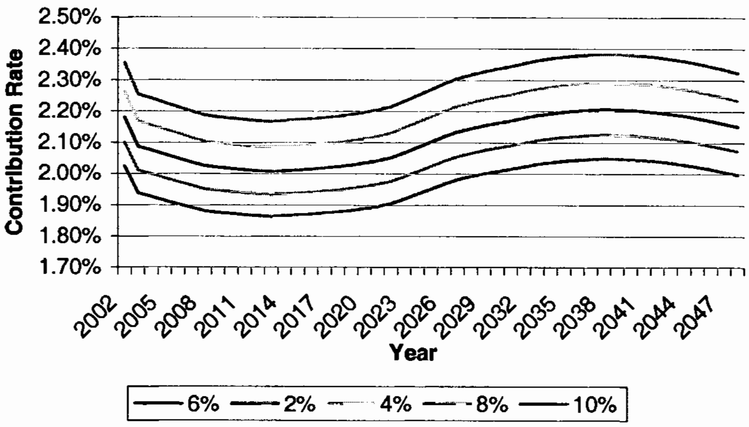


Figure 13: Sensitivity of $_1\theta_k$ and $_2\theta_k$ to increases and decreases in the prevailing interest rate.



2-Year Roll Forward Reserve: Varying Interest Rates



The behaviour of ${}_1\theta_k$ and ${}_2\theta_k$ with respect to each of the modified parameters in this sensitivity analysis is largely as intuitively expected. From a policy and planning perspective, these results should appear favourable given the reasonably narrow range of ${}_1\theta_k$ and ${}_2\theta_k$. Figures 9 to 13 indicate ${}_1\theta_k$ being in the range 1.60% to 2.90% and ${}_2\theta_k$ being in the range of 1.55% to 2.75%. Note that these contribution rates should be viewed as minimum requirements. We would perhaps expect the contribution rate used in practice to be marginally higher than these to both buffer adverse movement in the reserve and to provide smooth rates over time.

6 Issues to Consider

Exactly how these contribution rates could be implemented rests essentially on political viability. We envisage here a levy that would operate similarly to the current Medicare levy. There are, however, a number of other possible alternatives. For instance, McCallum et al. (1999) suggest that only a proportion of the contribution rate be levied to fund the *increased* costs of aged care. An obvious drawback to this is that it would require the continuing public subsidy of the current level of LTC requirements. Alternative means of implementing the contribution rate may be via an approved superannuation fund or private health insurance fund – the details of which we shall not consider here.

Achieving intergenerational equity will also be a challenge. That is, it would appear that intergenerational equity would not result until the time when all participants in the scheme start to contribute to the fund at a common age.

7 Comparing Social and Private LTC Insurance Premiums

The purpose of this section is to compare the results of the social LTC contribution rates calculated in this paper with the private LTC insurance premiums calculated in Leung (2004b). That is, we seek to compare costs for individuals under both a social LTC insurance scheme and in the absence of a social LTC insurance scheme. We encounter a number of difficulties in this exercise which are acknowledged as follows.

Firstly, the n-year roll forward contribution rates calculated in this paper are with respect to projected *aggregate* LTC costs as per Leung (2004a). That is, the social LTC insurance contribution rates were not calculated with reference to individual benefit levels as was the case with the private LTC insurance premiums. Again, given the unavailability of adequate LTC cost data at the individual level, attempts to compare private LTC insurance with social LTC insurance premiums is not straightforward. However, we believe that we have used a reasonable basis of comaparison here and, as such, our comparisons represent a realistic outlook on the relative amounts of premiums.

Furthermore, the n-year roll forward contribution rates calculated in this paper were based on projected *total* taxable payroll in Australia. The absence of suitable data precluded the projection of average salaries distributed according to age. Comparisons of premiums are necessarily age specific so further modelling was required to determine a proxy for the age distribution of projected taxable income which may then be applied to the calculated contribution rates to determine annual social LTC insurance premiums.

7.1 Age Distribution of Income

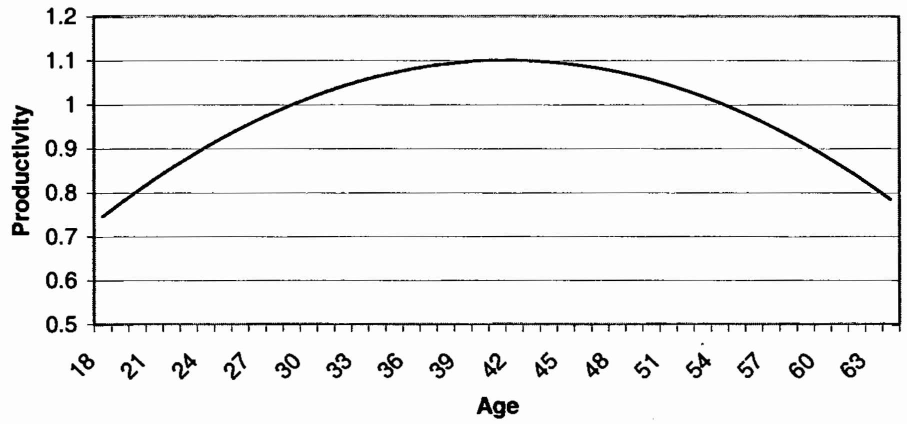
Given the unavailability of suitable data, we determine the age distribution of income in Australia by first modelling the age specific productivity of labour. Miles (1999) modelled the age specific productivity of labour for the UK labour force as a quadratic function of age with the parameters equal to the weighted average of the coefficients from sector specific age-earnings regressions applied to UK Family Expenditure Survey data. We use the same model and associated parameters used by Miles (1999) for the Australian population thereby assuming no inherent age-related structural differences between the UK labour force and the Australian labour force. We further assume that the Australian labour force is aged between 18 years and 65 years, is equally weighted across ages and that age specific labour productivity is the same for both males and females.

The log of the age-specific part of labour productivity as per Miles (1999) (assuming no aggregate, time-related productivity growth) is given as:

$$0.05age - 0.0006age^2 \qquad (11)$$

The unweighted average of labour productivity level as determined by equation (11) corresponds to the productivity level at age 29, so we re-scale our calculated age specific productivity values such that age 29 is attributed the value 1. Figure 14 illustrates the age profile of labour productivity taking into account only age specific and not time related productivity growth. We note that the quadratic profile of age specific labour productivity as illustrated in Figure 14 is consistent with Australian age-earning profiles in the literature (Bacon 1999, Borland and Wilkins 1996).

Figure 14: Age specific labour productivity.



By assuming average yearly earnings for both males and females as sourced from the ABS Survey of Average Weekly Earnings and discussed in Section 27of ABS (2001) occurring at the mean age for age specific labour productivity, we are able to determine an age distribution of income for both males and females by applying the age specific productivity values in Figure 14 to average yearly earnings. Income at each age is then forecast by again applying a TFP growth rate of 1.5% per year. Figures 15 and 16 show the projected age specific incomes at 5-yearly age intervals for both males and females respectively.

Figure 15: Projected age specific incomes: Males.

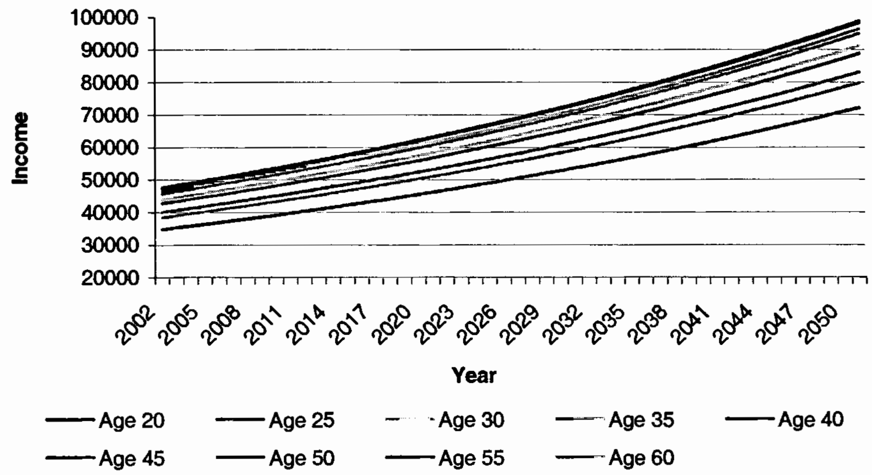
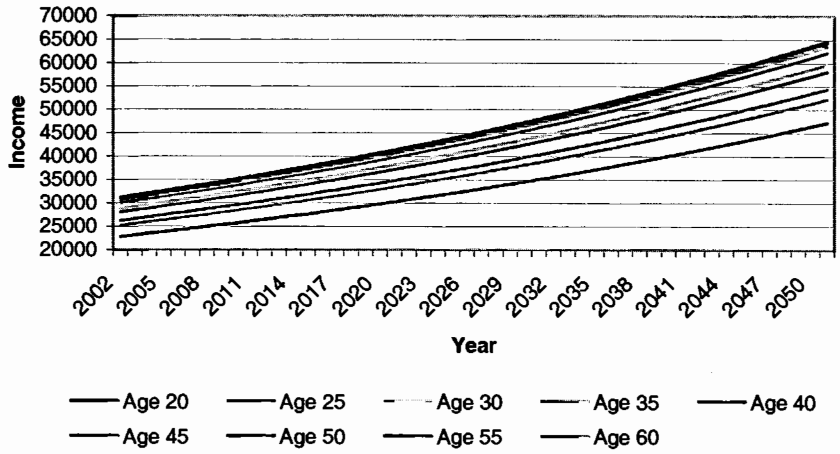


Figure 16: Projected age specific incomes: Females.



7.2 Age Specific Social LTC Premiums

By applying the calculated contribution rates to the projected age specific incomes, we are able to estimate the age-specific annual premiums payable by members of the social LTC insurance scheme each year. Tables 9 and 10 and Figures 17 and 18 report the annual social LTC premium payable for a 1-year roll forward reserve for both males and females at 5-yearly age intervals.

Figure 17: Annual Social LTC Insurance Premiums: Males.

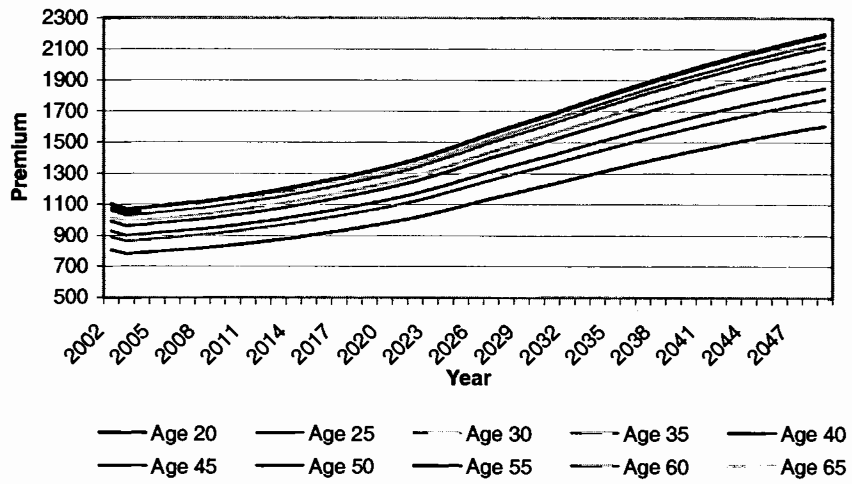


Figure 18: Annual Social LTC Insurance Premiums: Females.

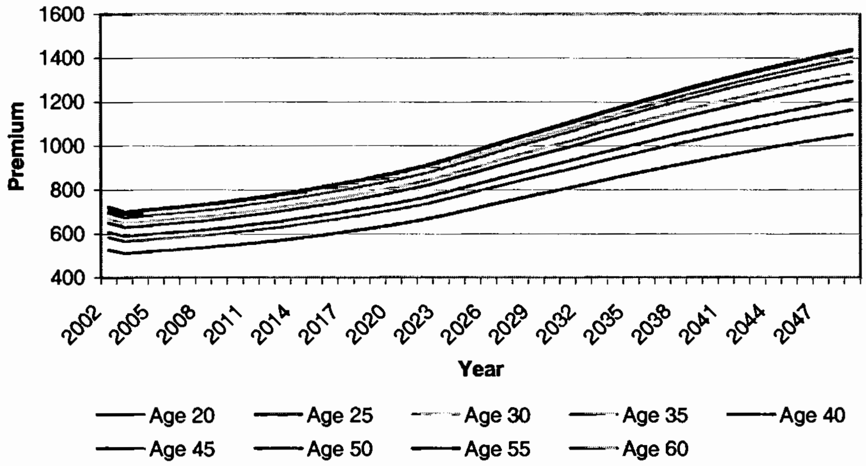


Table 9: Annual Social LTC Insurance Premiums ($): Males.

	Age								
Year	20	25	30	35	40	45	50	55	60
2004	790	910	998	1055	1081	1076	1040	972	873
2005	797	918	1007	1064	1091	1085	1049	980	881
2006	804	926	1015	1074	1100	1095	1058	989	888
2007	811	934	1025	1083	1110	1105	1067	998	897
2008	819	942	1034	1093	1120	1115	1077	1007	905
2009	829	954	1047	1107	1134	1129	1090	1020	916
2010	839	966	1060	1121	1149	1143	1105	1033	928
2011	850	979	1074	1136	1164	1158	1119	1046	940
2012	861	992	1088	1150	1179	1173	1133	1060	952
2013	873	1005	1103	1166	1195	1189	1149	1074	965
2014	887	1021	1120	1185	1214	1208	1167	1091	980
2015	901	1037	1138	1203	1233	1227	1185	1108	996
2016	915	1054	1156	1222	1253	1246	1204	1126	1012
2017	930	1071	1175	1243	1273	1267	1224	1145	1028
2018	946	1089	1194	1263	1294	1288	1244	1163	1045
2019	962	1108	1215	1285	1317	1310	1266	1184	1063
2020	979	1128	1237	1308	1340	1334	1289	1205	1082
2021	997	1148	1260	1332	1365	1358	1312	1227	1102
2022	1017	1171	1285	1358	1392	1385	1338	1251	1124
2023	1040	1198	1314	1389	1423	1417	1369	1280	1150
2024	1064	1225	1344	1422	1457	1450	1401	1309	1176
2025	1089	1254	1376	1455	1491	1484	1433	1340	1204
2026	1115	1284	1409	1489	1526	1519	1467	1372	1233
2027	1140	1313	1440	1523	1560	1553	1500	1403	1260
2028	1163	1339	1470	1554	1592	1584	1531	1431	1286
2029	1187	1366	1499	1585	1624	1616	1561	1460	1311
2030	1210	1393	1528	1616	1655	1647	1592	1488	1337
2031	1233	1419	1557	1646	1687	1679	1622	1516	1362
2032	1257	1448	1588	1679	1721	1712	1655	1547	1390
2033	1282	1476	1619	1712	1754	1746	1687	1577	1417
2034	1306	1503	1649	1744	1787	1778	1718	1606	1443
2035	1329	1530	1679	1775	1818	1810	1749	1635	1469
2036	1352	1556	1708	1805	1850	1841	1779	1663	1494
2037	1375	1583	1736	1836	1881	1872	1809	1691	1519
2038	1397	1608	1765	1866	1912	1903	1838	1719	1544
2039	1418	1633	1792	1894	1941	1932	1866	1745	1568
2040	1440	1657	1818	1923	1970	1961	1894	1771	1591
2041	1460	1681	1845	1950	1998	1989	1921	1797	1614
2042	1481	1705	1870	1977	2026	2016	1948	1822	1636
2043	1500	1727	1895	2004	2053	2043	1974	1846	1658
2044	1519	1749	1919	2029	2079	2069	1999	1869	1679
2045	1538	1771	1943	2054	2104	2094	2024	1892	1700

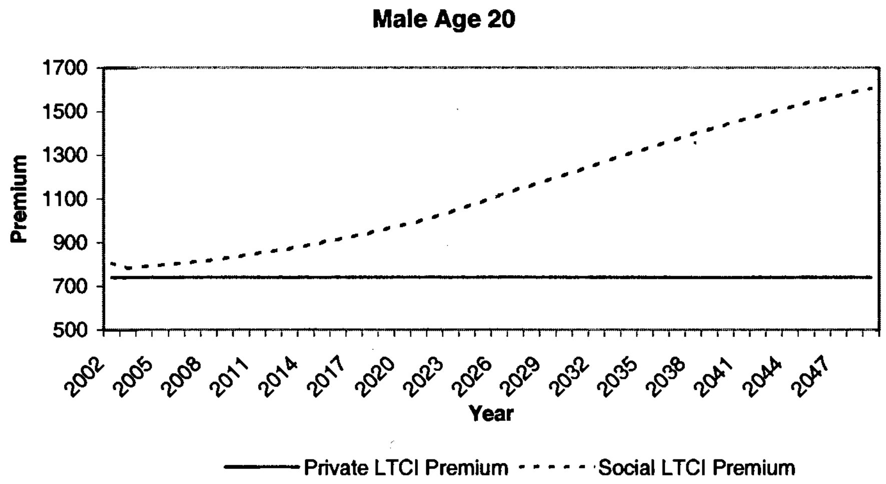
Table 10: Annual Social LTC Insurance Premiums ($): Females.

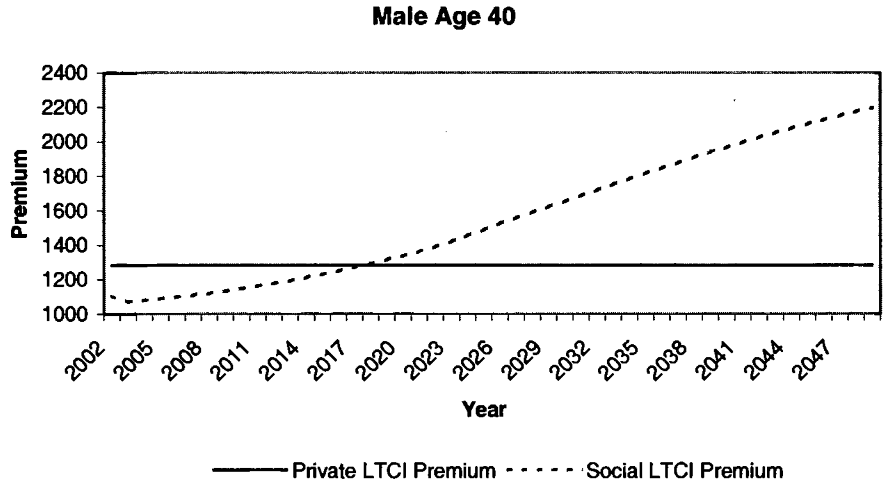
Year	20	25	30	35	40	45	50	55	60
2004	518	596	654	691	708	705	681	637	572
2005	522	601	660	697	715	711	687	642	577
2006	527	606	665	703	721	717	693	648	582
2007	531	612	671	710	727	724	699	654	587
2008	536	617	677	716	734	730	706	660	593
2009	543	625	686	725	743	740	715	668	600
2010	550	633	695	735	753	749	724	677	608
2011	557	641	704	744	762	759	733	685	616
2012	564	650	713	754	772	769	743	694	624
2013	572	659	723	764	783	779	753	704	632
2014	581	669	734	776	795	791	765	715	642
2015	590	680	746	788	808	804	777	726	652
2016	600	690	758	801	821	817	789	738	663
2017	610	702	770	814	834	830	802	750	674
2018	620	713	783	827	848	844	815	762	685
2019	630	726	796	842	863	859	830	776	697
2020	642	739	811	857	878	874	844	789	709
2021	653	752	825	873	894	890	860	804	722
2022	666	767	842	890	912	908	877	820	737
2023	682	785	861	910	933	928	897	839	753
2024	697	803	881	931	954	950	918	858	771
2025	714	822	902	953	977	972	939	878	789
2026	731	841	923	976	1000	995	961	899	808
2027	747	860	944	998	1022	1017	983	919	826
2028	762	878	963	1018	1043	1038	1003	938	843
2029	777	895	982	1038	1064	1059	1023	957	859
2030	793	913	1001	1059	1085	1079	1043	975	876
2031	808	930	1020	1079	1105	1100	1063	994	893
2032	824	949	1041	1100	1127	1122	1084	1014	911
2033	840	967	1061	1122	1149	1144	1105	1033	928
2034	855	985	1081	1142	1171	1165	1126	1052	946
2035	871	1002	1100	1163	1192	1186	1146	1071	962
2036	886	1020	1119	1183	1212	1206	1166	1090	979
2037	901	1037	1138	1203	1233	1227	1185	1108	996
2038	915	1054	1156	1223	1253	1247	1205	1126	1012
2039	929	1070	1174	1241	1272	1266	1223	1143	1027
2040	943	1086	1192	1260	1291	1285	1241	1160	1043
2041	957	1102	1209	1278	1309	1303	1259	1177	1058
2042	970	1117	1225	1296	1328	1321	1277	1194	1072
2043	983	1132	1242	1313	1345	1339	1294	1209	1087
2044	996	1146	1258	1330	1362	1356	1310	1225	1100
2045	1008	1160	1273	1346	1379	1372	1326	1240	1114

7.3 Premium Comparisons

We now compare the age specific social LTC premiums calculated above with the private LTC premiums calculated in Leung (2004b). Figures 19 and 20 illustrate a comparison of premiums at 20-yearly age intervals for both males and females respectively.

Figure 19: Comparison of Social and Private LTCI Premiums: Males.





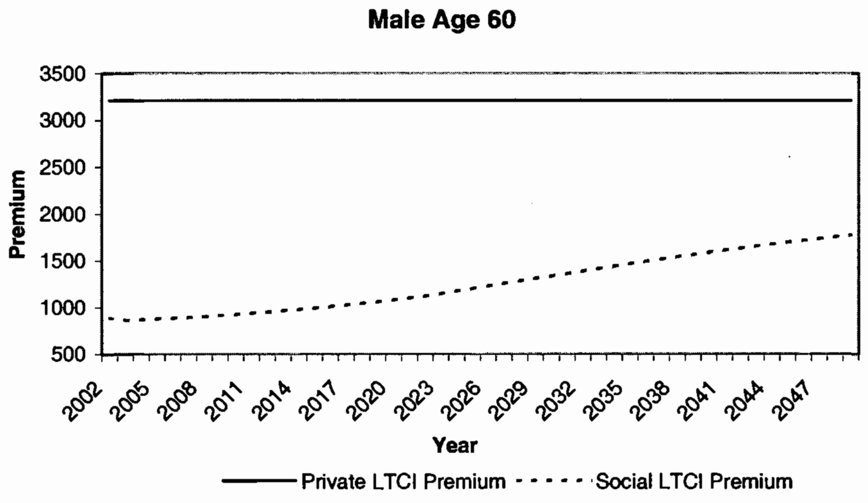
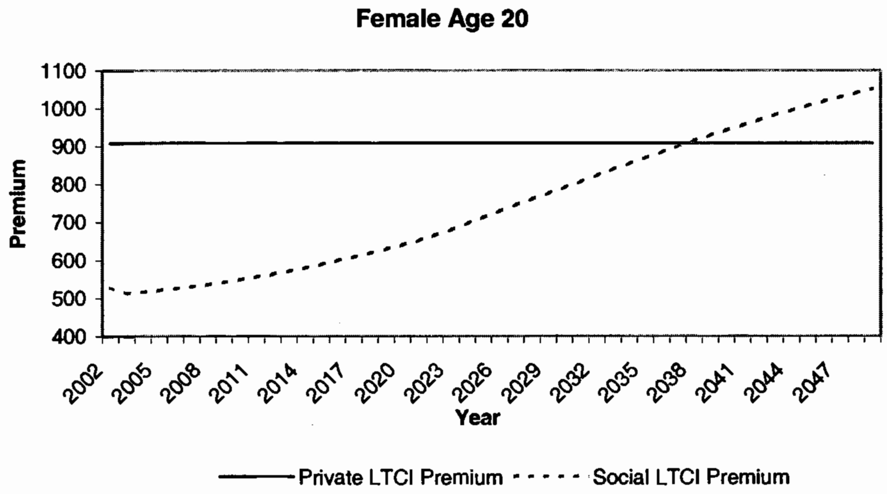
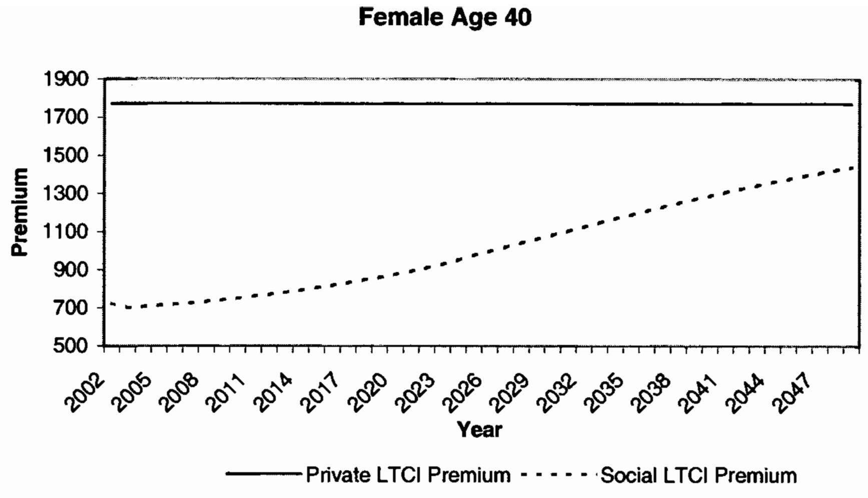
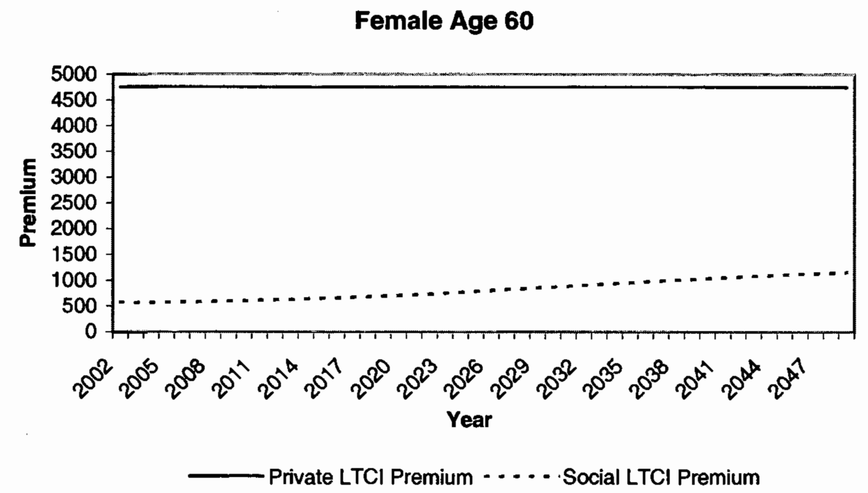


Figure 20: Comparison of Social and Private LTCI Premiums: Females.







Several key points should be noted. Social LTC insurance contributions for males are uniformly greater than private LTC insurance premiums at the younger ages. It is only until age 36 that the private LTC insurance premiums exceed social LTC insurance contributions. Nevertheless, the social LTC insurance premiums soon exceed private LTC insurance premiums owing to growth in income. It is only at the higher ages for males (greater than age 55) that the private LTC insurance premiums are uniformly higher than the social LTC insurance premiums. Furthermore, at no age are social LTC insurance premiums for females uniformly greater than female private LTC insurance premiums. Private LTC insurance premiums for females, however, uniformly exceed social LTC insurance premiums as early as age 35.

These observations lead to the following conclusions. First, given that the n-year roll forward contribution rates have been calculated with no distinction between males and females, it is not surprising that the social LTC insurance contributions appear relatively cheaper for females than the private LTC insurance premiums – particularly in light of the greater propensity for females to require LTC services and the lower average contributions by females to a social LTC insurance scheme by virtue of a relatively lower average income from which contributions may be levied. The implication of this is that under a social LTC insurance scheme, the evidence here suggests that male members would be effectively subsidising the LTC risk of females. In addition, the results also indicate that under a social LTC insurance scheme, the younger members would be effectively subsidising the older members who are at a greater risk of requiring LTC. Females, in particular, contribute significantly less than the actuarially fair private LTC insurance premium at higher ages.

These conclusions are largely consistent with the comparison of a PAYG funding system and private LTC insurance premiums in the UK by Burchardt (1997). More importantly, the results are instructive on equitable design issues if a social LTC insurance scheme is adopted for Australia. In particular, the evidence here suggests that contribution rates for n-year roll forward reserves may well require differentiation for males and females and/or differentiation with respect to income or age.

8 Conclusions, Limitations and Further Research

This chapter has focused on modelling a possible social insurance scheme to fund LTC requirements in Australia over the coming decades. We have considered an n-year roll forward reserving framework where Australians actively participating in the labour force contribute a percentage of their assessable income to a publicly administered social LTC insurance fund which provides for the costs of LTC to all Australians without age discrimination.

Using projections of the future needs and costs of LTC calculated in Leung (2004a) and other relevant projections of key macroeconomic variables, we presented 1-year and 2-year roll forward reserve profiles up to 2050. Furthermore, we determined contribution rates over the projection horizon that are necessary to support this social LTC insurance scheme. Our results indicate that the minimum necessary contribution rate to maintain 1-year or 2-year roll forward reserves is in the range 2.00% to 2.35% of total national taxable payroll. We have also presented several sets of contribution rates as part of a sensitivity analysis of the model with respect to several key model parameters. We found that the contribution rates were in a reasonably narrow range which is favourable from a planning perspective.

There are, however, several limitations of the model. Firstly, the projections of macroeconomic variables are only approximate. The long term nature of these projections has restricted the use of sophisticated forecasting techniques. We would expect that in practice, key parameters would be periodically forecast in the short run (perhaps 1 or 2 years) using the most recent experience. A second limitation is that the calculations assume no significant structural changes in the economy over the projection horizon. It is conceivable that labour market reform, taxation reform, LTC policy reform, or simply severe recession may well impact the ultimate contribution rate. Further research may consider the impact of structural shocks in the economy to the model.

A number of further areas of research have also been identified. We consider each in turn:

1. The 1-year and 2-year roll forward contribution rates are for the purpose of maintaining already existing 1-year and 2-year roll forward reserves. That is, we have implicitly assumed that there are already sufficient reserves in the fund to support the first 1 (or 2) years. How this is generated is more a policy question and has thus not been considered in this paper. There are, however, a variety of options – perhaps the most logical being imposing a waiting period while contributions accumulate to a sufficient level.
2. Another possible area of research is to investigate possible break downs of the contribution rate for different classes of person in the labour force. For example, differing contribution rates may be levied depending on the level of incomes or the full time/ part time status of the worker.
3. Investigate how to best choose a smoothed contribution rate and the impact of this on the reserve fund.
4. Consider methods for monitoring claims (see, for example, Tolley et al. 1989) to ensure there is adequate social insurance coverage without exceeding the budgeted reserves.

It is hoped that the results of this paper will contribute to increased discussion on social LTC insurance. Although the results of this paper suggest a LTC levy somewhat higher than the current Medicare levy, it appears reasonable in the context of the potential magnitude of LTC costs to the individual user. Ultimately, the introduction of such a scheme will inevitably fall on a political balancing act between the increased burden of a LTC levy compared to other benefits received through public savings from the elimination of public LTC subsidies.

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