THE FUTURE OF THE SOCIAL SECURITY PENSION PROVISION OF TRINIDAD AND TOBAGO USING LEE-CARTER FORECASTS

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ABSTRACT

This paper examines the future trends in the pension provision provided by the government of Trinidad and Tobago. I have looked at this in the context of global trends, namely the ageing of more developed populations, which is resulting in major shortfalls in many state pension provisions. These issues have been discussed in Chapter 1.

I have used the Lee-Carter model to predict future mortality rates based on published mortality rates for the period 1990-1999. I then used these predictions to estimate the number of pensioners as well as contributors for 2000-2004 and to determine the required future level of contributions. The Definition of the Model is found in Chapter 2, while the Results and the Analysis of past and future trends are presented in Chapter 3.

I have also summarised my findings in Chapter 4 along with solutions to trends found. In summary, I have predicted rising costs to provide future pensions, as a result of the ageing of the population (particularly the female population). There is no easy solution to control increased costs; however increasing the state retirement age may be the most promising option.

Key Words – Ageing, Longevity, State (Old Age) Pension provision, Dependency Ratio, Projection period, Mortality, Lee-Carter model, Age Cohort

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CHAPTER ONE: INTRODUCTION

1.10 Definitions of ageing

Ageing or "senescence" is one of the natural processes of life. Ageing refers to the decrease in the efficient functioning of an organism with age, outside of pathology and disease.

Victor (1987) refers to three biological theories of ageing. These are as a result of:

- The wear and tear of cells after a fixed time
- Cell programming
- A decline in the immune system

Old age can be defined in terms of a calendar age, or more commonly as when individuals are excluded from the labour market, or retirement age. When individuals have reached retirement age, they depend on state retirement benefits, company benefits and personal savings to provide an income in retirement. In some cases, due to the absence of the latter two forms of benefits, people depend solely on state retirement benefits.

1.20 The Global Phenomenon

The reality is that there is a global trend towards consistent patterns of improvements in life expectancy, or *longevity*. Demographers Jim Oeppen and James Vaupel noted that there is little evidence of nearing a natural cap on life expectancy – in Japan, significant mortality improvements are now being recorded at ages well above 80. These patterns have resulted due to many factors such as global economic development, improved standards of living, improved awareness or knowledge of detrimental health behaviours and medical discoveries.

The phenomenon of ageing is of relevance in developed and less developed countries alike, as the above issues have affected a wide cross-section of nations. For example, life expectancy for 1970-1975 in Trinidad and Tobago was 65.9 and has now been estimated at 71.4 for 2000-2005[i]. This paper examines the magnitude of the financial problems associated with the ageing population in Trinidad and Tobago over the first half of this decade, in the context of the adequacy of the social security pension provision (or the state pension provision).

1.30 Data Source

The primary source of demographic data for Trinidad and Tobago is from the country's Central Statistical Office (hereafter referred to as the CSO). All data used in this paper has been obtained from the CSO and I have assumed that all statistical reports to which I have referred below have obtained data from this source, unless otherwise specified.

1.40 Population Projections

Data for 1990-1999 has been used to predict mortality rates for 2000-2004, with projections compared against up-to-date values provided by the CSO. This 5-year projection period was chosen, as the latest available population data available from the CSO was for 2000 (with predictions up to 2003 based on 2000 census). The 10-year horizon for historic data is not ideal as in similar studies; 2-4 decades' worth of data is often used for projections 2 decades into the future. For example, Haberman and Renshaw (2003 a), predicted mortality rates from 1998-2020 (23 years) based on historic data from 1950 to 1998 (39 years). The limits on the past data have arisen due to the unavailability and the lack of confidence which was placed on the data for earlier periods.

1.50 Benefits provided by the State

In Trinidad and Tobago the National Insurance System (hereafter called the NI System) is a statutory mechanism which provides social benefits to those in need of financial support in the population. The main benefits provided are:

- The state retirement pension (for those who may or may not have been employed)
- The widow's benefit
- The disability benefit (this is provided for those individuals who are physically or mentally disabled).

I have analysed the state pension provision only, that is, all other state benefits (including retirement benefits) have been ignored.

1.60 State Pension Provision

The State Pension provision, better known as the "Old Age Pension provision", coordinated by the government of Trinidad and Tobago, is an unfunded pension scheme (a pay-as-you-go scheme). Pension payments are therefore funded as a tax on the working population, all of which is paid out as benefits. For an average level of benefit, the following formula applies;

Number of contributors x Average contribution =

Number of pensioners x Average benefit per pensioner **(Equation 1.61)**

where,

Average contribution per worker =

$$\left\{\frac{\text{Number of retirees}}{\text{Number of contributors}}\right\} \times \text{Average benefit per retiree}$$

"Dependency ratio" **(Equation 1.62)**

The average contribution per worker is defined as:

Tax rate x Average taxable wage **(Equation 1.63)**

However, the tax is defined as a fixed sum based on an employee's annual salary. The employer and employee contribute at different levels, as set out by salary-banded contributions.

CHAPTER TWO: METHODOLOGY

2.10 Cohort/Period Approach to Analysing Mortality

Mortality analysis examines changes in mortality, μ_{xt} [ii], as a function of both age, x and time, t. The analysis of the mortality of a group of individuals can be done in two ways (Hatzopoulos, 1997). The *cohort* or *generational* approach examines the mortality of a cohort (individuals all born at the same time period), from the birth of the first to the death of the last. It therefore looks at the influence of a birth cohort on mortality. The *period* approach is a very effective and useful tool and is the approach used for this paper. With this approach, mortality rates which apply are those which prevail in the time period for which they are constructed.

2.20 Calculations

In order to quantify the level of contributions necessary for the state pension provision in Trinidad and Tobago, I have predicted future dependency ratios. The process entailed predicting mortality rates for the working population and retirees over the projection period. This was necessary to predict the cost of the pension benefit to be provided, based on the number of pensioners and contributors in the projection period.

2.30 THE LEE-CARTER MODEL

The model chosen to forecast mortality rates is the Lee-Carter Model (1992). Tabeau (2001) describes this model as a 'statistical association model which combines a demographic model with statistical time series analysis'. It is classified as a member of the class of log-linear models, and is therefore a member of the class of generalised linear models (GLIM).

According to the *period* approach to forecasting (Section 2.10), forecasts for calendar years 2000 to 2004 were obtained based on mortality data for the decade 1990 to 1999. The Lee-Carter method uses extrapolation of historic data to forecast the level and age pattern of mortality. It does not forecast population sizes directly, but models the rate of decline of the individual death rates. This decline naturally leads to the increase in the size of the population at each age.

2.31 Definitions used in the model

The Lee-Carter model is based on the central death rate[iii], where,

$$m_x = 2q_x \Big/ 2 - q_x \qquad \textbf{(Equation 2.311)}$$

where,

$m_x \equiv$ the central death rate at age x = $d_x \big/ l_x$

$q_x \equiv$ the probability of dying between ages x and x+1

2.32 The Definition of the Model

The Lee-Carter model is defined as:

[iv] $\ln m_{xt} = \alpha_x + \beta_x \kappa_t + \varepsilon_t$ (Haberman and Renshaw, 2003a) **(Equation 2.321)**

where,

$m_{xt} \equiv$ the central death mortality for age x at time t

$\alpha_x \equiv$ the average of the natural log of the mortality rates at age x over time

$\beta_x \equiv$ the age-specific pattern of mortality change

$\kappa_t \equiv$ the variation in the level of mortality with t

$\varepsilon_t \equiv$ the error term at time t

The central death mortality rate can defined by the following relationship:

$$m_{xt} = d_{xt} \Big/ e_{xt} \qquad \textbf{(Equation 2.322)}$$

where,

$d_{xt} \equiv$ the number of deaths at age *x* at time *t,* and

$e_{xt} \equiv$ the matching person-years of exposure to the risk of death

For the purpose of the projections of this paper, I have used the above relationship in the following form, based on the data provided by the CSO (d_{xt} and m_{xt}).

$$\hat{e}_{xt} = d_{xt} \Big/ m_{xt}$$ **(Equation 2.323)**

For any given data, the above matrix of data defined in Equation 2.321, is linked across calendar year (t) and age (x) for:

$t = t, t\ +1, \ldots, t_1 + h - 1 = t_n, and$

$x = x_{1,} x_2, \ldots, x_k$

where, k represents the number of ordered categories of x

and h represents the range of calendar years t ($h = t_n - t_1 + 1$)

Based on the data provided by the CSO used for the projections (1990-1999), h is 10.

The data provided was banded by quinquennial ages, also known as cohorts, (except for over 80's, which was classified as one cohort) as follows:

0-4, 5-9, 10-14, 15-19,…….., 80+

This resulted in 17 cohorts, with k = 17.

2.33 Fitting The Model[v]

The model cannot be fit by simple regression, because there are no observed values on the right hand side of Equation 2.321 and the parameterised structure of the model is bilinear.

A least squares solution exists for the parameters on the right hand side of the equation, but is not unique. In order to make it unique, two further conditions are applied to the model as follows:

$$\sum_{t=t_1}^{t} \kappa_t = 0$$ **(Equation 2.331)**

and,

$$\sum_{allx} \beta_x = 1$$ **(Equation 2.332)**

These conditions are referred to as normalising conditions. Therefore, rearranging Equation 2.321, the result is:

$$\ln m_{xt} = \alpha_x + \beta_x \kappa_t + \varepsilon_t$$

$$\Rightarrow \alpha_x = \ln m_{xt} - \beta_x \kappa_t - \varepsilon_t$$ **(Equation 2.333)**

and, summing the above equation over all x, and applying the constraints specified in Equations 2.331 and 2.332 above, we have,

$$\sum_{\forall x} \alpha_x = \prod_{t=t_1}^{t_n} \ln m_{xt} - \sum_{t=t_1}^{t_n} \beta_x \kappa_t - \sum_{t=t_1}^{t_n} \varepsilon_t$$

$$\Rightarrow \sum_{\forall x} \alpha_x = \prod_{t=t_1}^{t_n} \ln m_{xt} \Rightarrow$$

$$\hat{\alpha}_x = \ln \prod_{t=t_1}^{t_n} m_{xt}^{1/h}$$ **(Equation 2.334)**

The model has been fit as follows:

- ***Step 1 - Calculation of***: $\hat{\alpha}_x = \ln \prod_{t=t_1}^{t_n} \ln m_{xt}^{1/h}$
- ***Step 2 - Computation of***: $z_{xt} = (\ln(m_{xt}) - \hat{\alpha}_x)$
- ***Step 3 - Estimation of***: $\hat{\kappa}_t = \sum_{\forall x} z_{xt}$
- ***Step 4 - Regression of***: $\hat{\beta}_t = \sum_{\forall x} z_{xt}$ on $\hat{\kappa}_t$ for all x (with no intercept term)

It should be noted here that standard methods for fitting the Lee-Carter model (see Haberman and Renshaw 2003 a/b, or Wilmoth, 1993) utilise the technique of singular value decomposition of the matrix z_{xt} obtain $\hat{\kappa}_t$ and $\hat{\beta}_t$. I have chosen to use the approximation to singular value decomposition[vi], as described in steps 3 and 4 above, as this was easily facilitated using Microsoft Excel.

Due to the method I adopted for the smoothing of mortality rates, I have not aligned the actual total observed deaths with the total expected deaths for each year t, as has been done in the papers mentioned above.

2.34 Residuals

The approach for calculating residuals has been adopted from the methodology in Haberman and Renshaw (2003 a).

The calculation of the residuals was done as follows:

$$\hat{\varepsilon}_{xt} = \ln(m_{xt}) - \hat{\alpha}_x - \hat{\beta}_x \hat{\kappa}_t \qquad \textbf{(Equation 2.341)}$$

The residuals $\hat{\varepsilon}_{xt}$ were standardised by dividing by the following factor:

$$\sqrt{\left(\sum_{\forall xt} \hat{\varepsilon}_{xt}^{2} \Big/ \nu\right)}_t \qquad \textbf{(Equation 2.342)}$$

where, $\nu =$ (k-1)(h-2), with k and h are defined in Section 2.32

Therefore, $\nu = 16 \times 9 = 144$

2.35 Forecasting

The forecast method for the model has been adopted based on an adaptation to the approach used by Haberman and Renshaw (2003 a). The forecast period for this paper is from 2000 to 2004 based on data from 1990 to 1999.

Forecasts were carried out by modelling $\hat{\kappa}_t$ linearly, based on calculated values from 1990 to 1999. A "best-fit" linear equation[vii] was obtained and forecasts were calculated for the projection period of 5 years into the future, that is, from the years 2000 to 2004. The forecasts for $\hat{\kappa}_t$ were denoted by $\{\dot{\kappa}_{t_{n+s}} : s = 1, 2, \ldots, 5\}$, where $\dot{\kappa}_{t_n}$ were computed based on the solution for $\hat{\kappa}_t$ for the calendar year 1999.

The forecast mortality rates were then derived as follows;

$$\dot{m}_{x,t_{n+s}} = m_{xt_n} \exp\{\hat{\beta}_x(\dot{\kappa}_{t_{n+s}} - \hat{\kappa}_{t_n})\} \qquad \textbf{(Equation 2.351)}$$

The m_{xt_n} terms in Equation 2.351 were those observed for 1999.

2.40 DISCUSSION ON FORECASTING

There are two broad types of forecasts: *deterministic* and *stochastic*. A *deterministic* forecast fixes its assumptions at the outset and usually produces a point forecast and an interval forecast. A point forecast is a single-valued forecast for a single quantity while an interval forecast contains a point forecast as well as a high and low forecast. This type of forecast specifies time changes over the projected period in terms of deterministic equations or assumptions.

A *stochastic* forecast can be carried out using assumed probability distributions for variables in an otherwise deterministic forecast. Many simulations are run and results also form a probability distribution. This type of forecast may be generated by specifying time changes over the forecast period in terms of random dynamically changing equations or assumptions.

The Lee-Carter forecasts described above are an example of stochastic forecasts, using random dynamically changing equations. However, based on my adaptation of the model, I have only produced deterministic forecasts.

2.41 Analysis of the Model

According to Benjamin and Pollard (1993) the projection of age-specific mortality rates is best done by the process of extrapolation.

- The Lee-Carter model was chosen as it extrapolates mortality rates into the future based on past trends. That is, it attempted to capture underlying trends in the raw data and to project these, with the assumption that these trends will continue into the future. In so doing, all existing data was utilised to predict future mortality trends.
- The model also took into account the randomness or variations of events and allowed these variations to accumulate as they do in real life.
- In addition, the model was easily applied. I have done all calculations using functions of the spreadsheet package, Microsoft Excel. This facilitated the prediction of mortality rates based on the model.

There are some drawbacks of the model, which include:

- Under the Lee-Carter model, time is modelled as a multiplicative factor and together with β_x is estimated based on an appropriate data matrix. Therefore, this method has the potential to be inflexible with respect to age.
- Past trends may not be indicative of future trends. The method assumes a constant change in the pattern of mortality, when in fact the rates of decline in mortality may change.
- It does not incorporate subjective information about future trends such as medical discoveries or new diseases.
- The forecasts do not reflect uncertainty as to whether the model is correct or appropriate for the data being used.

2.42 Applications of the Model in the Past

- The Lee-Carter method was used to predict US death rates from 1900 to 1989 by Ronald Lee and Timothy Miller in their paper Entitled 'Assessing the Performance of the Lee-Carter Approach to Modelling and Forecasting Mortality', which was published in 2000. The forecasts accounted for 92.7% of the variance of mortality rates within each age group.

- The life expectancy of the US population was calculated in 1989 by Lee (2000). The Lee-Carter method produced a value for e_0 as 75.66 compared to an actual life expectancy of 75.08 in the calendar year. The projected gain in life expectancy was also calculated for the period 1989 to 1997 to be 1.5 years under this approach, compared to an actual gain over the period of 1.4 years.

- The Lee-Carter approach was used to forecast mortality for males and females based on the England and Wales mortality experiences of the past half-century, by Haberman and Renshaw (2003 a). These results were compared with those under the generalized linear model approach.

CHAPTER THREE: RESULTS

3.10 APPLICATION OF THE MODEL TO THE DATA AND RESULTS

The model was applied as described in Section 2.30 based on mortality rates for Trinidad and Tobago from 1990-1999, for the total, the male and the female populations.

However, the crude mortality rates were smoothed before the model was fit for males, females and the total population. I applied linear smoothing technique to the rates with the following results:

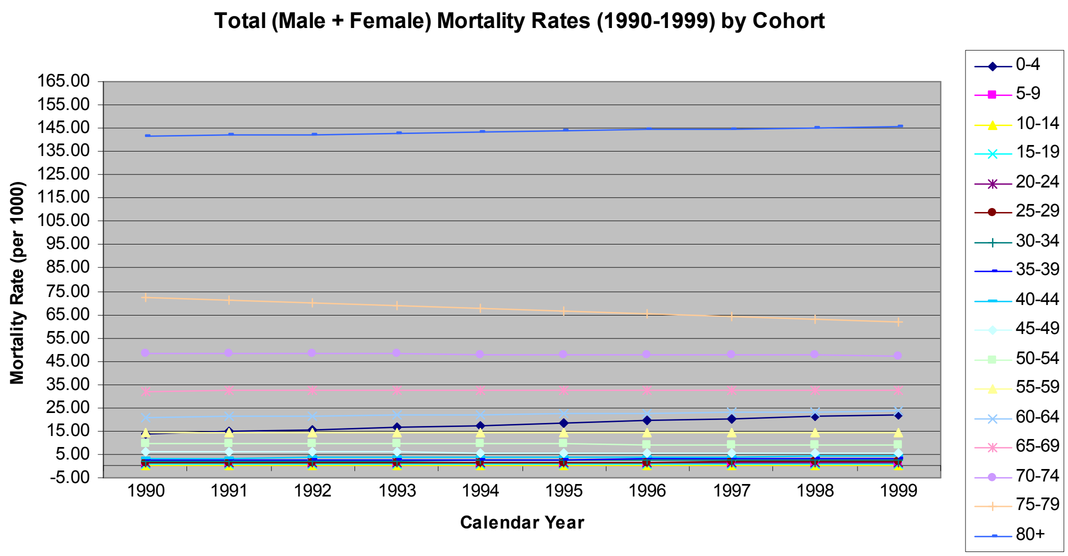
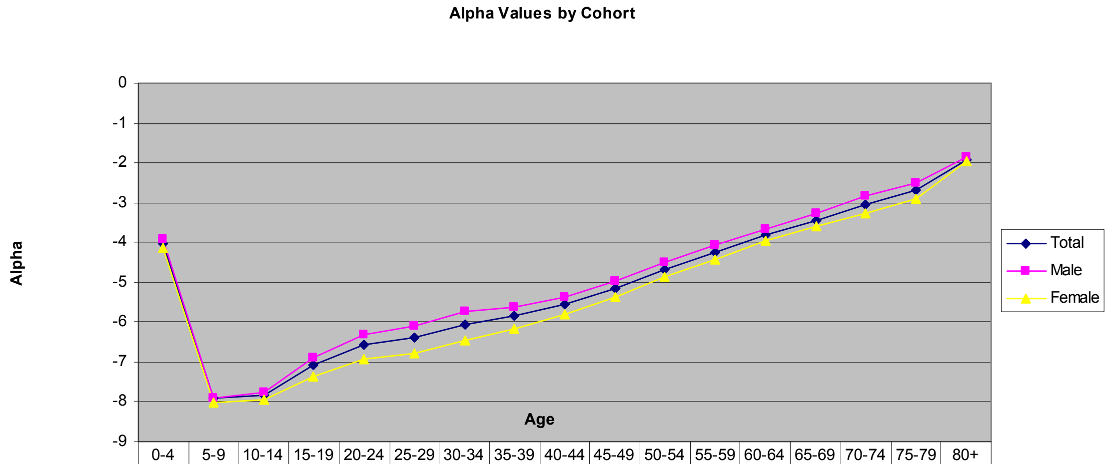


Figure 3.10: Smoothed Mortality Rates

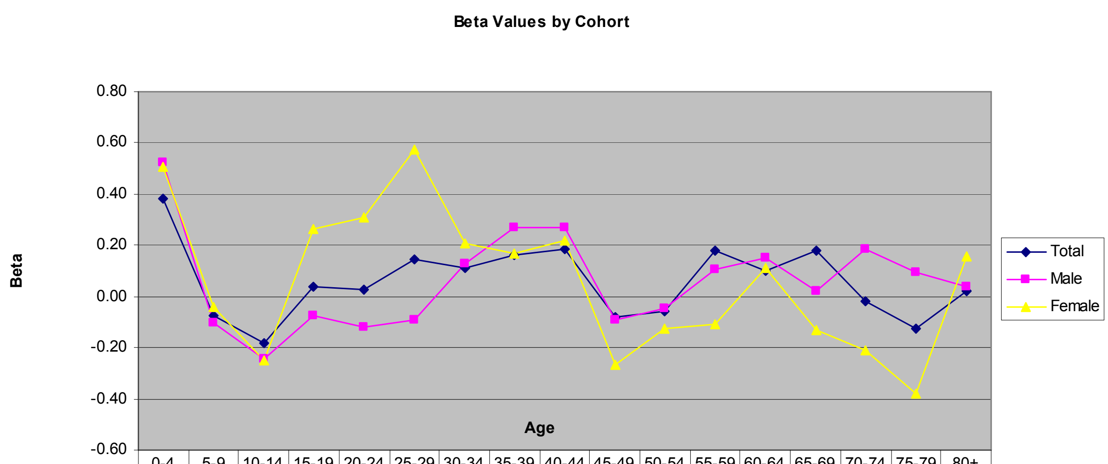
The rates illustrated in Figure 3.10 represent the mortality rates used to fit the Lee-Carter model. The calculated values for the parameters in Equation 2.32 ($\ln m_{xt} = \alpha_x + \beta_x \kappa_t + \varepsilon_t$), are shown below:



	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Total	-4.028	-7.906	-7.845	-7.089	-6.566	-6.386	-6.052	-5.86	-5.57	-5.152	-4.664	-4.236	-3.801	-3.433	-3.037	-2.702	-1.941
Male	-3.923	-7.906	-7.75	-6.884	-6.312	-6.103	-5.752	-5.63	-5.384	-4.96	-4.508	-4.064	-3.676	-3.274	-2.829	-2.507	-1.856
Female	-4.15	-8.013	-7.959	-7.365	-6.932	-6.8	-6.474	-6.162	-5.808	-5.363	-4.851	-4.432	-3.942	-3.603	-3.254	-2.888	-1.97

Figure 3.11: α_x

Figure 3.11 above shows the fitted values for α_x , which is the average of ln m_{xt}, for each age cohort from 1990-1999 (Equation 2.334). The pattern for the total, male and female rates is similar; mortality rates in Trinidad and Tobago increase with age. The exception to this generalisation is in the 0-4 cohort, where the rates of mortality are comparable to the 55-59 cohort, due to infant mortality.



	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Total	0.38	-0.07	-0.18	0.04	0.03	0.15	0.11	0.16	0.18	-0.08	-0.06	0.18	0.10	0.18	-0.02	-0.12	0.02
Male	0.52	-0.10	-0.25	-0.08	-0.12	-0.09	0.13	0.27	0.27	-0.09	-0.05	0.11	0.15	0.02	0.19	0.09	0.04
Female	0.51	-0.04	-0.25	0.27	0.31	0.57	0.20	0.17	0.22	-0.27	-0.13	-0.11	0.11	-0.13	-0.21	-0.38	0.16

Figure 3.12: β_x

Figure 3.12 above shows the fitted β_x values, or the age-specific pattern of mortality change over the period 1990-1999. The results for the total population, males and females have shown some similarities and differences worth noting.

All three plots show that mortality has deteriorated over time in the 0-4, 35-39, 40-44 and the 60-64 cohorts. For the total values, mortality improvements have been noted at advanced ages, that is, from ages 70-80+, as well as from 5-14 and 45-54. The pattern of mortality over time for all other cohorts is stable or gently increasing.

For the male fit, mortality rates were increasing at a fast rate in the 35-39 and 40-44 cohorts. They are, however, decreasing from 15-24 and 45-49. For females, mortality rates were increasing from 15-44, with a significant increase in the 25-29 cohort. At more advanced ages, notably from 65-79, rates are decreasing significantly.

The shape of the total curve is more similar to that of the female curve. That is, the magnitude of the fitted values differs, but the pattern of increase or decrease in mortality rates with age, is similar. The above analysis of the β_x values reveals that the shape of the total curve has been influenced to a greater extent of the change in the female rates at various ages.

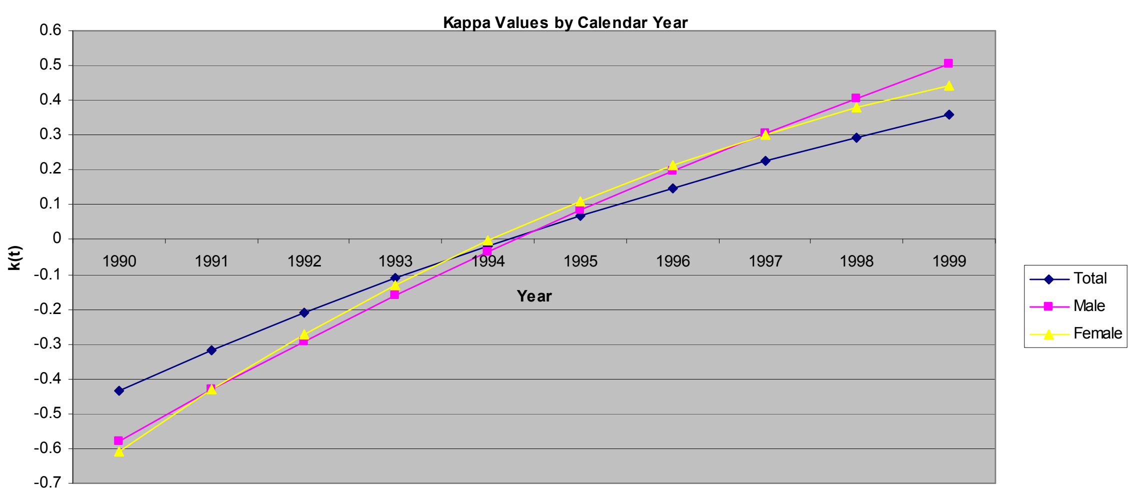


Figure 3.13: κ_t

The fitted values for κ_t represent the time trend, as shown in Figure 3.13. The shape of the three curves is similar, with rates increasing over the first 5-year period and decreasing thereafter.

The residuals for the total, male and female data were negligible, when calculated by calendar year or age. The values were on average 2 x 10^{-3}, so no adjustment was made to consider these. Interim results and data used for the above calculations can be provided on request.

The fitted projections are based on the values for α_x , β_x and κ_t. It is important to note that the combined effect of the average of past mortality rates, the age-specific pattern of mortality and the time trend, yield the forecasts. Therefore, in spite of the increasing time trend as illustrated by the shape of κ_t, it is possible for mortality improvements to be generated (Figure 3.22), based on the values for α_x and β_x.

3.20 PROJECTION METHODOLOGY

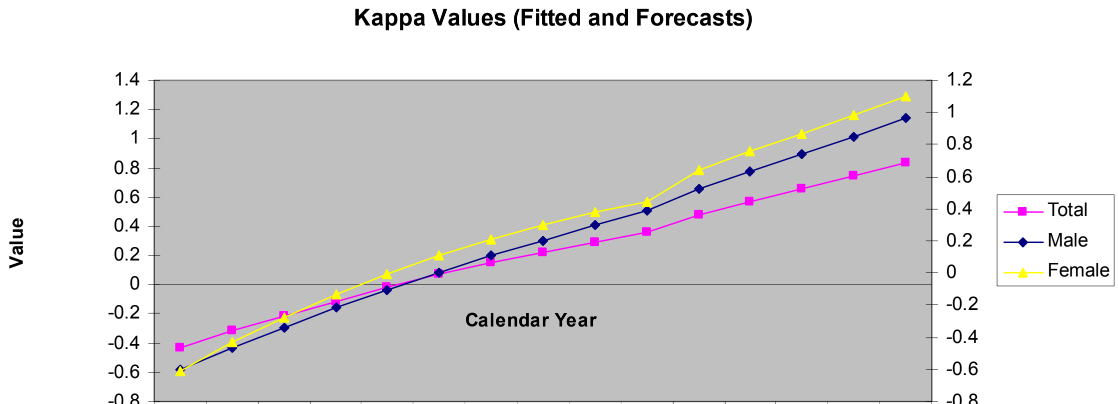
3.21 Forecasts

Forecasts were carried out by modelling $\hat{\kappa}_t$ using the method described in Section 3.26. The resulting equations and results calculated for $\hat{\kappa}_t$ are:

Total $\Rightarrow$ y = 0.0876x – 0.4821

Male $\Rightarrow$ y = 0.1198x – 0.6590

Female $\Rightarrow$ y = 0.116x – 0.6379



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total	-0.43	-0.32	-0.21	-0.11	-0.02	0.068	0.149	0.224	0.294	0.359	0.482	0.569	0.657	0.744	0.832
Male	-0.58	-0.43	-0.29	-0.16	-0.03	0.084	0.197	0.305	0.407	0.503	0.659	0.779	0.898	1.018	1.138
Female	-0.61	-0.43	-0.27	-0.13	-0	0.111	0.213	0.302	0.378	0.443	0.638	0.754	0.87	0.986	1.102

FIGURE 3.21

The projected mortality rates for 2000-2004, $\dot{m}_{x,t_{n+s}}$ as defined in Equation 3.261 are:

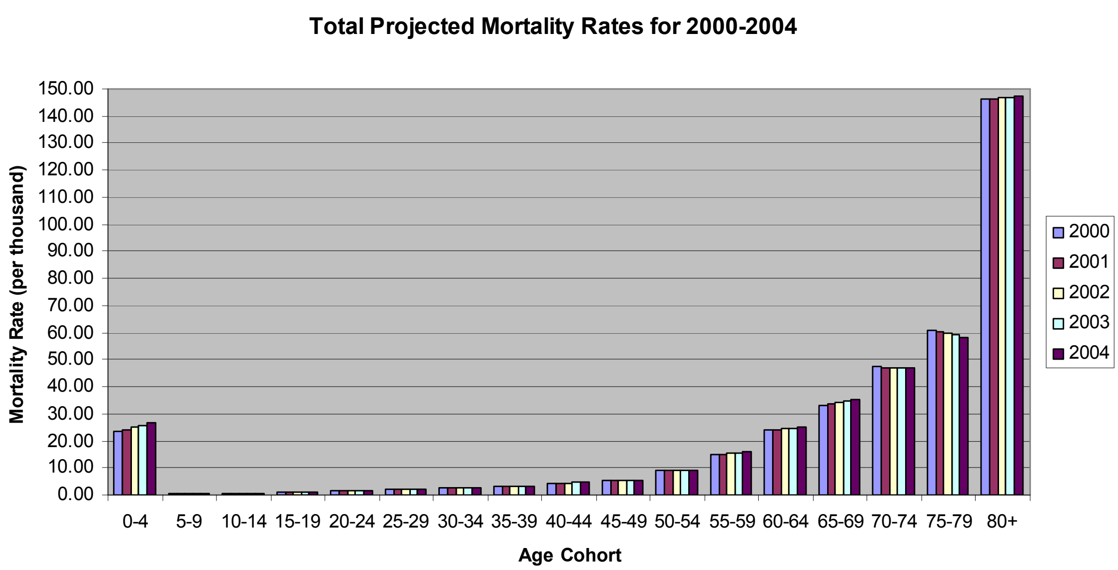


FIGURE 3.22

In the projection period (2000-2004), the mortality rates for older ages (65-80+), have shown a pattern of decline (Figure 3.22). The cohort experiencing the largest level of decline was the 75-79 cohort, followed by the 70-74 cohort. The 65-69 and 80+ cohort, displayed patterns of a slight increase in mortality rates.

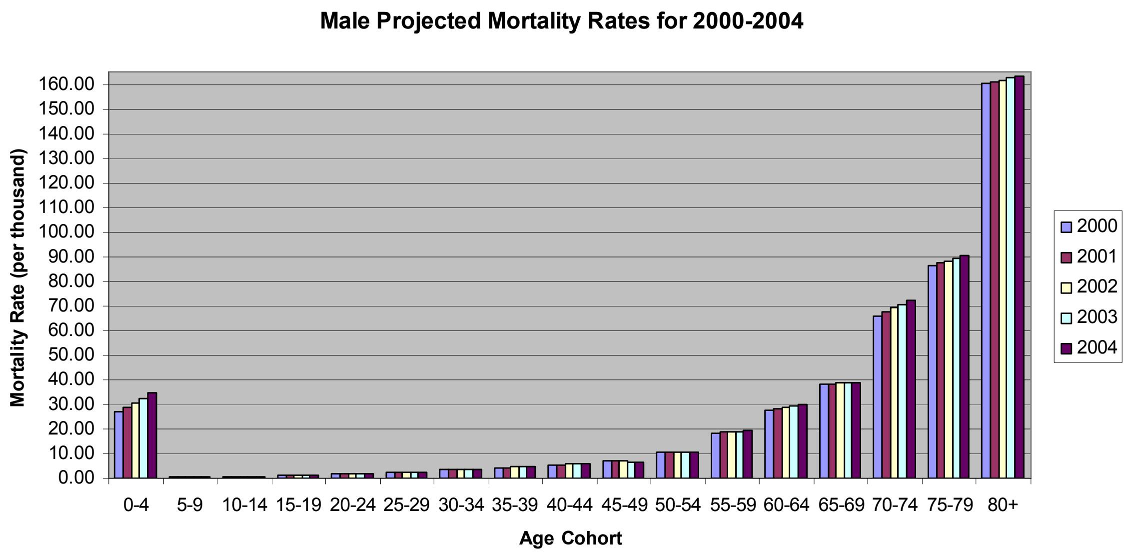


FIGURE 3.23

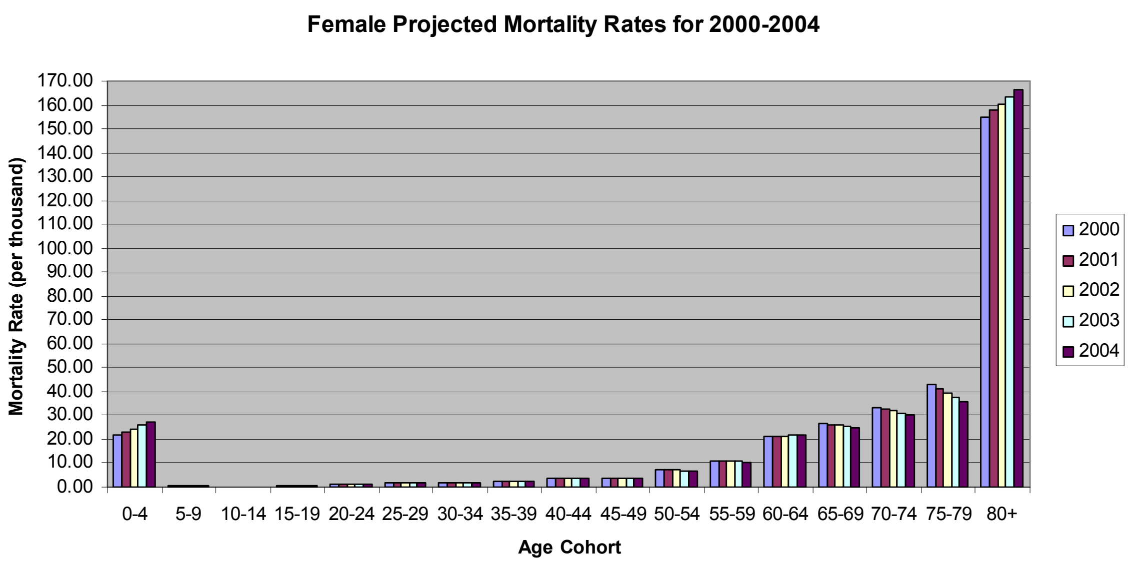


FIGURE 3.24

On comparing Figure 3.22 with Figures 3.23 and 3.24, the trend towards mortality improvements at older ages experienced by the total population, is mainly influenced by the pattern of females in the population. Females are therefore predicted to live longer than men, and to die at more and more advanced ages.

3.22 Population Projections

Based on the projected death rates calculated under the Lee-Carter model, the population by age and gender was projected to the end of each projection year using the following method:

Population Projection Methodology

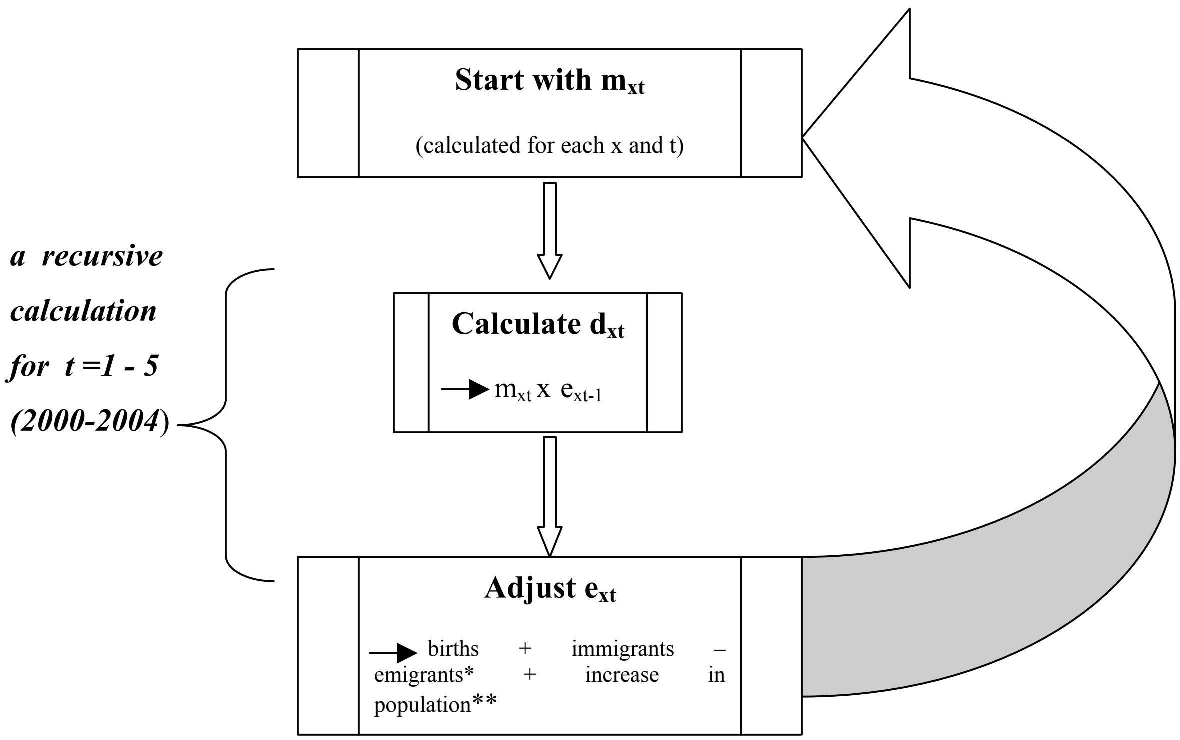


FIGURE 3.221

*The net effect of immigrants – emigrants was assumed to be zero.
**The increase in population was based on values given by the CSO for the projection period

3.30 Results of the Population Projections

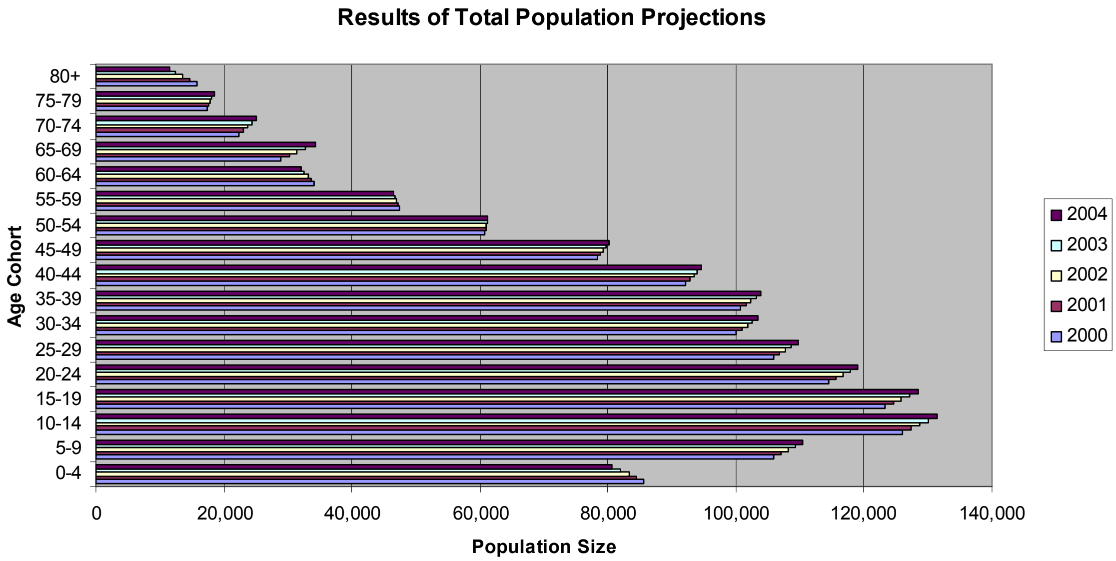


FIGURE 3.30

The total population structure (Figure 3.30), changes in an interesting manner over the projection period. The pattern of change in the 20+ cohorts, will impact on future dependency ratios, so these cohorts will be examined exclusively.

The cohorts which include ages 20 to 54 have increased in absolute size over the period, while there has been a decrease in the 55-59 and 60-64 cohorts. The overall effect was an increase to the total working population of approximately 2% over the 5-year projection period.

All the cohorts applicable to those of pensionable age (that is 65+), have increased in size, except for the 80+ cohort. The overall effect is that the number of pensioners has increased by 5% over the period. The dependency ratio is therefore expected to increase by approximately (5-3)%, 2% over 2000-2004 and it can be said that the population is ‘ageing or ‘growing old’.

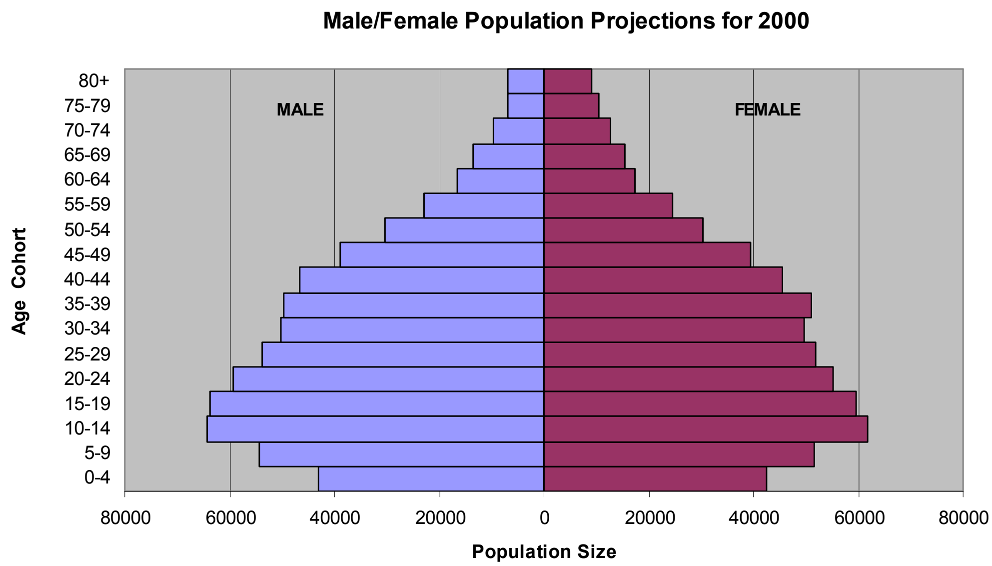


FIGURE 3.31

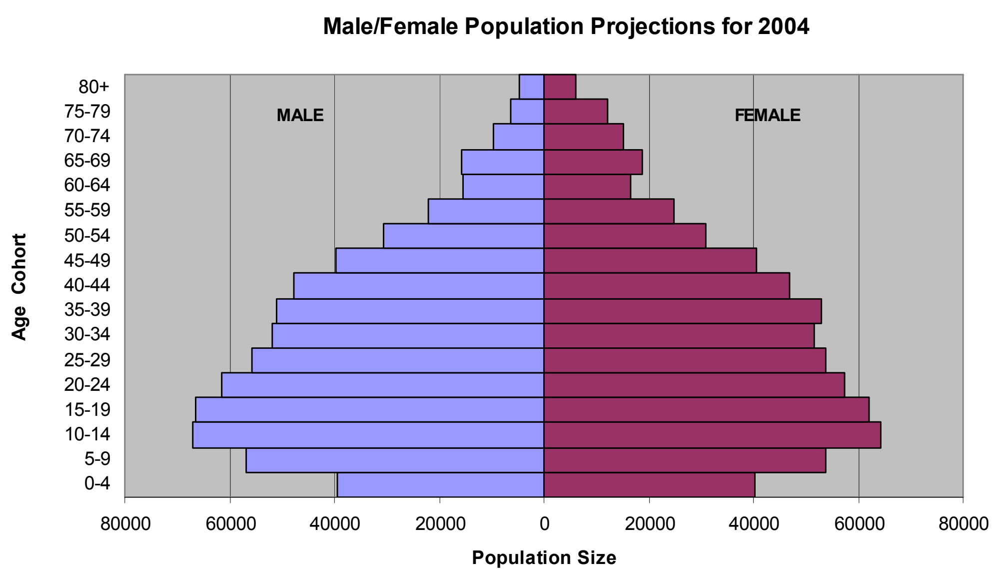


FIGURE 3.32

The population pyramids in Figures 3.31 and 3.32, further illustrate the changing demographic structure of the population as shown in Figure 3.30, but by sex. The results over the period show that the ageing of the population has resulted because the percentage growth in the size of the pensioner population has been greater than that of the working population. Pensioners are said to experience 'longevity' (Section 1.20).

On further examination of the results, it is apparent that this overall pattern has been influenced mainly by the mortality improvements experienced by females, particularly at advanced ages. In spite of the male cohorts being larger than comparable female cohorts, the females have contributed more to the new population structure.

3.31 Comparison of Projection Results

The results of the projections were compared with similar results from the CSO. The CSO provided total population estimates[viii] for 2000-2003 (based on the unconfirmed results from the 2000 census), and these values were compared with the total population and the combined (male + female) population, based on the Lee-Carter projections. The Lee-Carter projections were re-grouped to reflect the age cohorts provided by the CSO's estimates, in order to facilitate the comparison of all three results.

The graphs below illustrate the results.

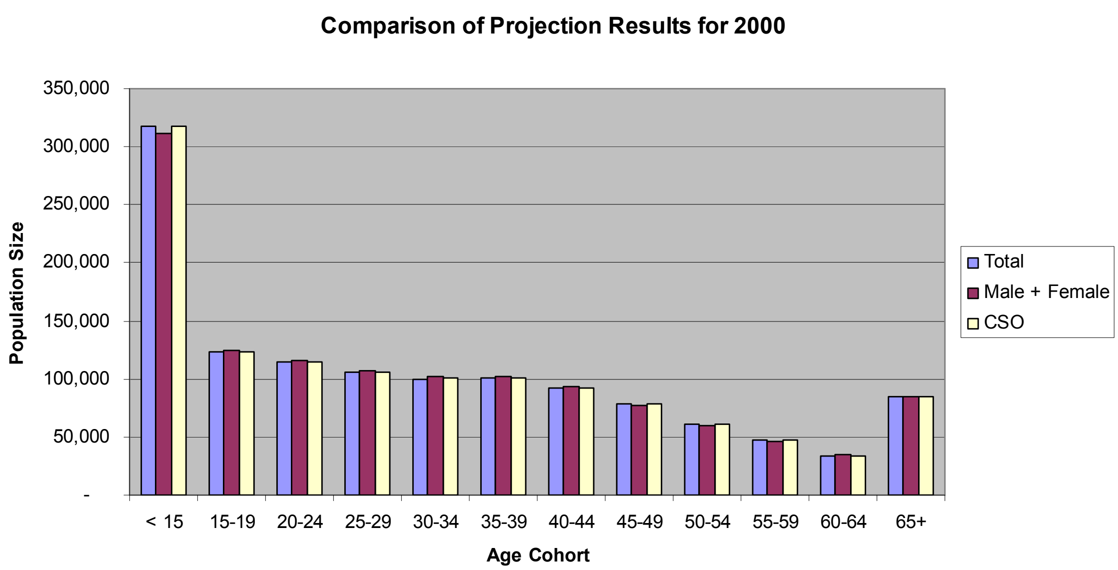


FIGURE 3.311

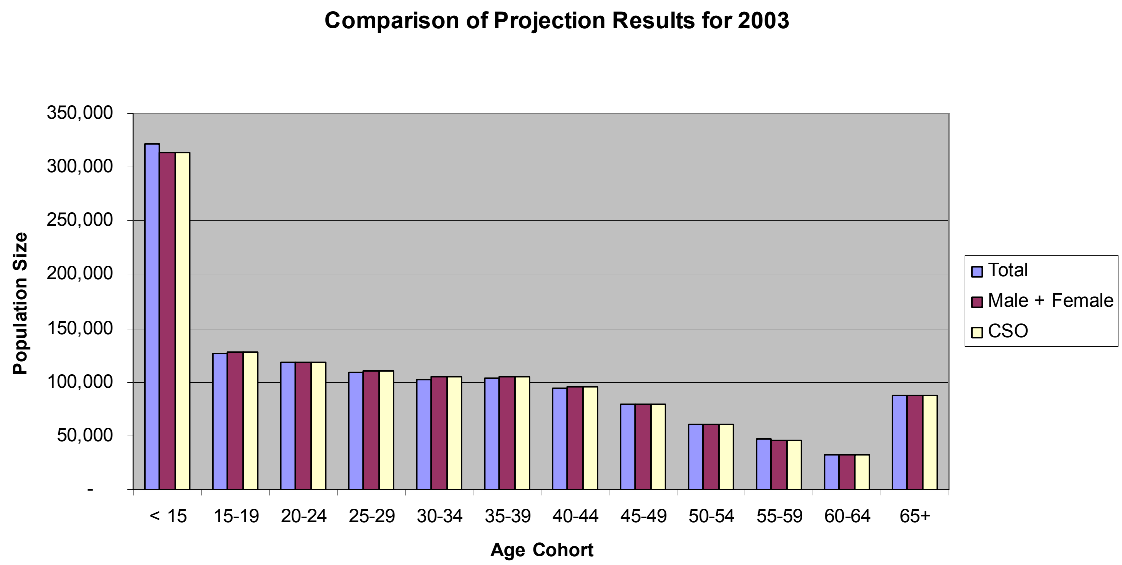


FIGURE 3.312

The results show that the total population size under the three scenarios is quite similar. In comparing the CSO's results with the total and (male + female) populations, the difference is no more than +/- 0.6%. The projections produced in the paper are therefore considered reliable.

3.40 DEPENDENCY RATIOS

3.41 Calculation Method

Dependency ratios for the projection years 2000-2004, as well as for the 1990-1999, have been calculated for Trinidad and Tobago. The dependency ratios have been calculated using a consistent method for all the years. Important points to note in the calculation of the ratio are:

- The ratio is defined as:-

  beneficiaries of the state pension provision (aged 65+) :

  the working population

- The population aged 65+ included the 65-69, 70-74, 75-79, 80-84 and 85+ cohorts.
- The working population was estimated as 60% of the population aged 20+, based on recommendations by the CSO. The approximation considered unemployment as well as those unable to be employed. The ratio did not include those in the 15-19 cohort, as a significant proportion of this cohort is either in full-time education or unemployed.

3.42 Results

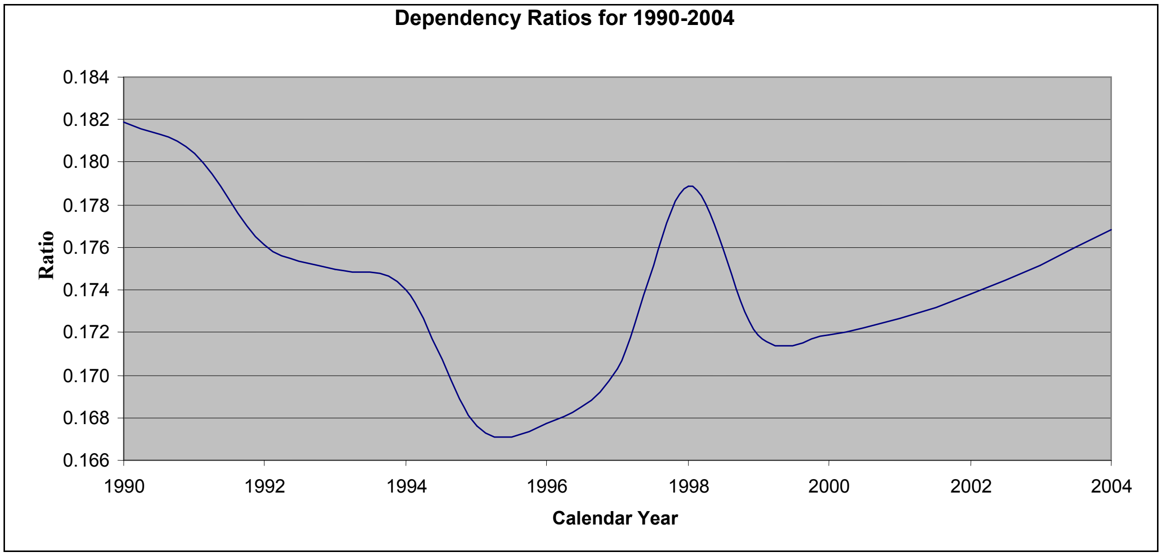


FIGURE 3.421

The graphical depiction of the dependency ratios shows instability in the values based on the unsmoothed data provided by the CSO. The dependency ratios for 1990-1995 showed little cause for concern due to the downward shape of the curve. This implied that those receiving a state pension were becoming less and less of a 'burden' on the working population. However, from 1999-2004 the curve is increasing. Furthermore, if the shape of the curve continues into the future, the process of extrapolation shows that by 2010, the dependency ratio will approach 0.185.

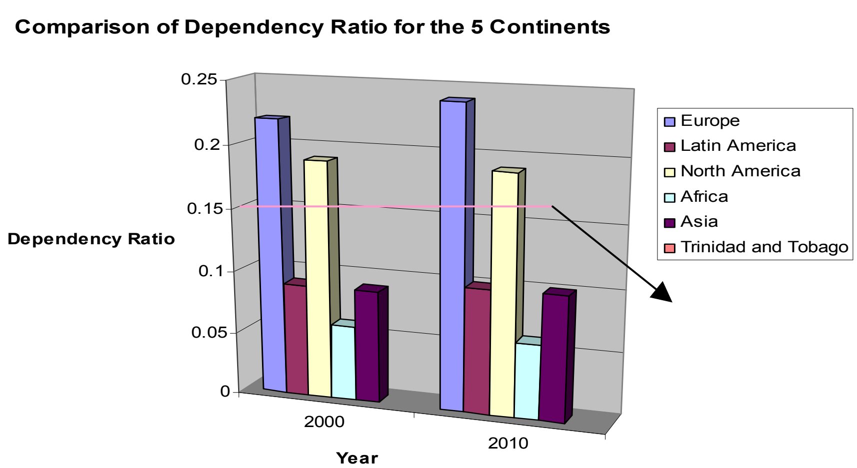


FIGURE 3.422

Data Source: UN Population Division: World Population Prospects: 2002 Revision

For completeness, I have plotted the above dependency ratio comparison. All ratios have been calculated as the population over age 65 as a fraction of the working population. The level of the dependency ratios for Trinidad and Tobago has been in line with those for North America over the period.

3.50 REQUIRED CONTRIBUTION RATE

The 'burden' (Section 3.42) of the state pension provision in Trinidad and Tobago falls on the working population. As described in Section 1.70, this burden is funded solely by a tax on the working population, under the NI system.

3.51 Calculations

Due to the structure of the NI contributions paid in Trinidad and Tobago (Section 1.60), the calculation of the required contribution rates for the projection period required some assumptions to be made as follows:

- The level of contributions was calculated based on the actual average monthly earnings for each projection year. This information was obtained from the CSO.
- The average salary for 2010 was calculated as the average salary as at 2004 accumulated at the current annual rate of inflation[ix], (3%) for 6 years.
- The monthly cost of the provision was calculated as the product of the old age pension (at the actual historic levels) and the number of pensioners.

3.52 Results – Cost of pensions

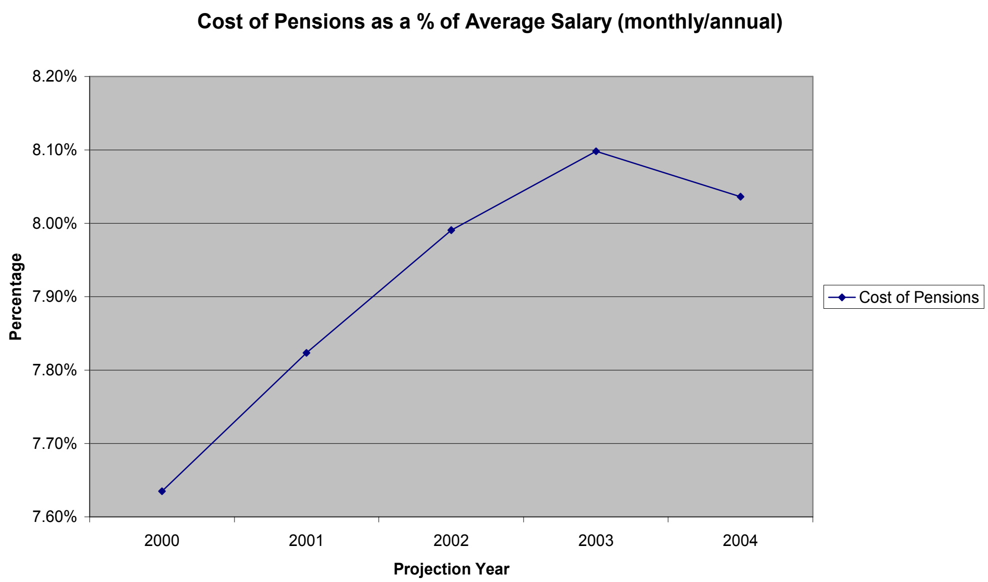


FIGURE 3.52

The results are not surprising. Based on the Lee-Carter model projections of the population structure for 2000-2004, the cost of the old age pension provision is becoming more burdensome to the working population. Extrapolation shows that the rate may rise to 8.4% in 2010, which results in a 10-year increase of 10%.

CHAPTER FOUR: CONCLUSIONS AND RECOMMENDATIONS

4.10 CONCLUSIONS

- The global phenomenon of ageing or longevity has been affecting Trinidad and Tobago over the last decade and is predicted to affect the country over the next decade.
- This is coupled with the pattern of general mortality improvements experienced at most ages. General mortality improvements have affected adults of working age as well, but not to the same extent as the elderly of the population.
- Many social and economic factors have contributed to this situation and are likely to continue to do so.
- The pattern of longevity in the overall population is influenced mainly by the past and future trends in female mortality rates at advanced ages.
- The ratio of pensioners to working population has been increasing and is expected to increase in the future.
- This implies that the current contributions to the unfunded social security scheme (based on the current age profile of the population), will not be sufficient to pay future pensions.

4.20 RECOMMENDATIONS

- Increasing the state retirement age will lower and add stability to the contribution rates, but this change will require a long period of time to be introduced.
- The government can also consider increasing contribution rates or restructuring the system in its entirety.
- Costs of all options should be carefully considered before implementing.
- The government should sensitise the population as to the gravity of the situation to avoid disenchantment when it decides to implement new policies.

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ENDNOTES

[i] Human Development Index report produced by the UNDP for 2002

[ii] Actuarial notation

[iii] The definition of the Lee-Carter model is based on the definition developed by Lee and Carter in 1992 (Lee, 2000). The central death rate is an actuarial definition as per Bowers et al 1986.

[iv] Haberman and Renshaw (2003) have used the base 10 logarithm in their definition. I have used the natural logarithm assumption in this paper based on Wilmoth's (1993) definition of m_{xt} in terms of e.

[v] The model was fit using calculations in Excel to produce results.

[vi] Described by Haberman and Renshaw (2003 c) and by email correspondence with Timothy Miller.

[vii] Haberman and Renshaw (2003 a) modelled $\hat{\kappa}_t$ as an ARIMA(0,1,0) process.

[viii] This was the most up-to-date information from the CSO. It was subject to confirmation.

[ix] This was obtained from the 2004-2005 Budget presentation for Trinidad & Tobago delivered by Prime Minister Patrick Manning – Source: The Trinidad Express Newspaper, 8 October, 2004.

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