THE IMPACT OF POPULATION AND LABOUR FORCE SCENARIOS ON SUPERANNUATION, TAX EXPENDITURES AND PENSION COSTS.

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This paper presents modelling results which show how major demographic trends and alternative scenarios impact on important Australian aggregates such as the asset holdings of Superannuation Funds and Age and Service Pension costs.

The paper discusses briefly recent major trends in demographic factors, particularly fertility and mortality and important labour force trends such as the changing workforce participation patterns of women. Projecting the likely course of these trends in detail over a time scale exceeding 50 years is difficult but necessary for the modelling work of the RIM Task Force. To facilitate this work and particularly to give greater accuracy in estimating the population at higher age ranges, a population projection model POPMOD has been built and is described.

Using the Task Force's enhanced version of the National Mutual Retirement Incomes Policy Model (RIP), the impact of varying immigration levels on the assets of superannuation funds, pension costs, tax expenditures and national savings is examined. Given the potential importance of mortality assumptions, variations of the single mortality assumption of the Australian Bureau of Statistics are constructed and the sensitivity assessed, particularly of the aggregate costs of government pensions.

The results presented in relation to the labour force show considerable sensitivity of aggregates to the age of entry to the workforce. Following parameter adjustments, the current base RIP runs indicate a somewhat higher impact of the Superannuation Guarantee on national savings than the results published in the FitzGerald Report on National Savings.

Derivation of the estimated value, and range of uncertainty, of Superannuation assets in the year 2000 is used to exemplify sensitivity analysis to a range of other important parameters, such as inflation rates and the earning rates of superannuation funds, additional to the demographic ones.

Overall, the aggregates produced by the RIP model, with its associated analytical framework, are shown to be quite robust to a range of views about the future. The new aggregate model of the Task Force (RIMGROUP), now under development, will maintain the strengths of RIP and add to them.

The Retirement Income Modelling Task Force is equally financed by the Departments of Treasury, Finance and Social Security from the reallocation of existing resources.

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INTRODUCTION

The Retirement Income Modelling (RIM) Task Force is a joint project of the Commonwealth Departments of the Treasury, Finance and Social Security and has as its principal object "to develop a capacity for modelling the impact of retirement income policies over the next half century and provide advice to departments and Ministers as required on policy options affecting retirement incomes." The Task Force is concerned with dynamic simulation modelling of the interaction of superannuation, labour markets, social security and taxation at both an aggregate and individual-based level. Attachment A sets out the full Terms of Reference.

As is well known, Australia will experience a marked ageing of the population over the next half century: the aged dependency ratio has increased from 13% in 1972 to 18% in 1993 and is predicted to rise to 37% by 2059. Accordingly the research and modelling efforts of the Task Force rely heavily on long run demographic projections with particular emphasis on labour force participation, the retirement decision and mortality. Projections are required out to at least 2051, about the time when a full generation will have benefited from a fully phased in Superannuation Guarantee. The demographic variables of interest to RIM include population totals, sex and age structure, fertility, deaths, migration, workforce participation, disability, retirement, pensions, and to a lesser extent family formation, marriage and divorce.

The models used by the Task Force comprise both hypothetical models, which cover one individual or a couple or income unit, and aggregate group models. The current individual model is called INDMOD. The aggregate group model currently used by Task Force is a RIM enhanced version of the National Mutual Retirement Income Policy Model, affectionately known as RIP. It projects age by sex cohorts covering the full Australian population and calculates aggregates for superannuation and retirement incomes by modelling the accumulation and payout phases for each major type of superannuation and the interaction with the tax and age pension systems. Improved models of both thehypothetical and aggregate type are under development (RIMHYPO and RIMGROUP). As required by the Terms of Reference we have developed the capacity to carry out sensitivity analysis to a range of alternative assumptions, both in respect of demographic and a wide range of other parameters. As part of this development, a new population model, POPMOD, has been constructed and its features are described.

This paper adds to the earlier publications of the Task Force (Brown, 1993; Gallagher et al,1993; Gallagher and Preston, 1993) by discussing how major demographic trends and alternative scenarios impact on important Australian aggregates such as the asset holdings of Superannuation Funds and the combined costs of Age and Service Pensions. Specifically the paper first discusses briefly recent major trends in demographic factors, particularly fertility and mortality and important labour force trends such as the changing workforce participation patterns of women. Plausible scenarios consistent with these trends and expert views are constructed and the sensitivity of key aggregates to scenario choice is examined. Derivation of the best estimate of Superannuation assets in the year 2000 is used to exemplify sensitivity analysis to a range of other important parameters, such as inflation rates and the earning rates of superannuation funds, additional to the demographic ones.

DEMOGRAPHIC BACKGROUND

Australia's population as at June 1993 was estimated to be 17.6 million and is expected to grow to around 24 million by 2031 and 26 million by 2051 (Australian Bureau of Statistics, 1994; Bacon, 1994). The annual rate of population growth has fallen from around 1.71% in 1989 to 1.02% in 1993 and, based on the most likely scenario from the Australian Bureau of Statistics (ABS), will fall to 0.2% by 2051. Due to a rapid decline in birth rates and the impact of the "baby boom" cohort, Australia will experience a largely inevitable ageing of the population over the next half century, with a doubling of the ratio of people of retirement age compared with those of working age.

Fertility

Australia's total fertility rate declined rapidly during the 1970's, stabilised during the 1980's and has shown some increase in the 1990's . Apart from the general decline in birth rates from the trend towards smaller families, age specific data (Bureau of Immigration and Population Research, 1994) shows the clear trend for women to defer having children until their late twenties and later. ABS provides three possible fertility projections (low, medium, and high) as the basis of its various population projections (Australian Bureau of Statistics, 1994).

Apart from the explicit population dynamics, the fertility rate is of importance because of its effect on labour force participation. Most women leave the work force for some period while their children are young. This will have a significant effect on their superannuation accumulations due to the interruption(s) to their work experience and the timing of these interruptions.

Mortality

In Australia the crude death rate has fallen from around 9 per thousand in the 1960's to about 6.9 per thousand in 1993. The decline in mortality has occurred in all age groups and is predicted to continue into the next century. Women have a lower mortality rate than men and consequently have a higher life expectancy. The greatest difference in mortality rates occur for young adults with men aged 20-29 years three times as likely to die than women in this age range (Bacon, 1994).

Apart from their impact on population aggregates, mortality rates are clearly important in our context in impacting significantly on age pension costs, on withdrawals from the superannuation system and on annuity rates. While the ABS use only one set of mortality assumptions, the extent of uncertainty that applies over the timescale of our modelling and the potential importance of these parameters has influenced the Task Force to construct its own alternatives of an even greater decline in mortality rates at older ages- the 'healthy lifestyles' option and a pessimistic (perhaps extreme) alternative of no continuing improvement at all in mortality rates.

LABOUR FORCE TRENDS

For our modelling work, basic projections of numbers of people in the age range broadly defined as working age must be accompanied by projections of labour force participation by age and sex, unemployment rates, and of patterns of work including the proportion of work which is part time.

Taken together these determine the numbers employed in our models and influence average salaries; these in turn have a first order affect on the level of contributions and superannuation funds held.

There have been major changes taking place in the Australian labour force, including:

- the dramatic increase in the labour force participation of women;
- changing patterns of female participation associated with changes in the age of having a first child;
- decreased labour force participation at older ages, particularly of men;
- less time in the workforce reflecting longer periods spent in education; and
- a trend to increasing part time work as a proportion of all work.

Accordingly views must be taken on whether and/or for how long these trends will continue and sensitivity analysis done to reflect a range of plausible outcomes. Sensitivity analysis is important in this area as the relevant Australian Bureau of Statistics (ABS) and the Department of Employment, Education and Training (DEET) and academic experts agree that there is no successful sophisticated methodology for projecting the labour force either in Australia or overseas. The approach which is agreed to be the most practical and which has been used in Australia is as follows:

- apply simple linear regression techniques to age/gender specific labour force participation rates;
- apply upper and lower bounds incorporating rules such as requiring that the participation rates for women will not exceed that of men of the same age and that the participation rate for women in Australia will not exceed that of some other countries such as Sweden which have more extensive facilities and arrangements to encourage the participation of women in the labour force than does Australia; and
- apply other subjective adjustments as necessary.

There are three available Australian projections all based broadly on this methodology. They have been carried out by the ABS, DEET and the Department of the Prime Minister and Cabinet.(see ABS, 1991; DEET, 1991 and the Department of the Prime Minister and Cabinet, 1992). None of the projections go past 2005. Our current base parameters for the RIP model are set out in Table 1 below and have been based essentially on the DEET projections but also reflecting the higher values in the ABS and PM & C data bearing in mind the convenience of the ABS data being readily available in more detail. For all years past 2005 we have used the default assumption of no further change**.** Original versions of RIP ignored labour force trends.

Table 1

Labour Force Participation Rate in RIP, by Age and Year

Women

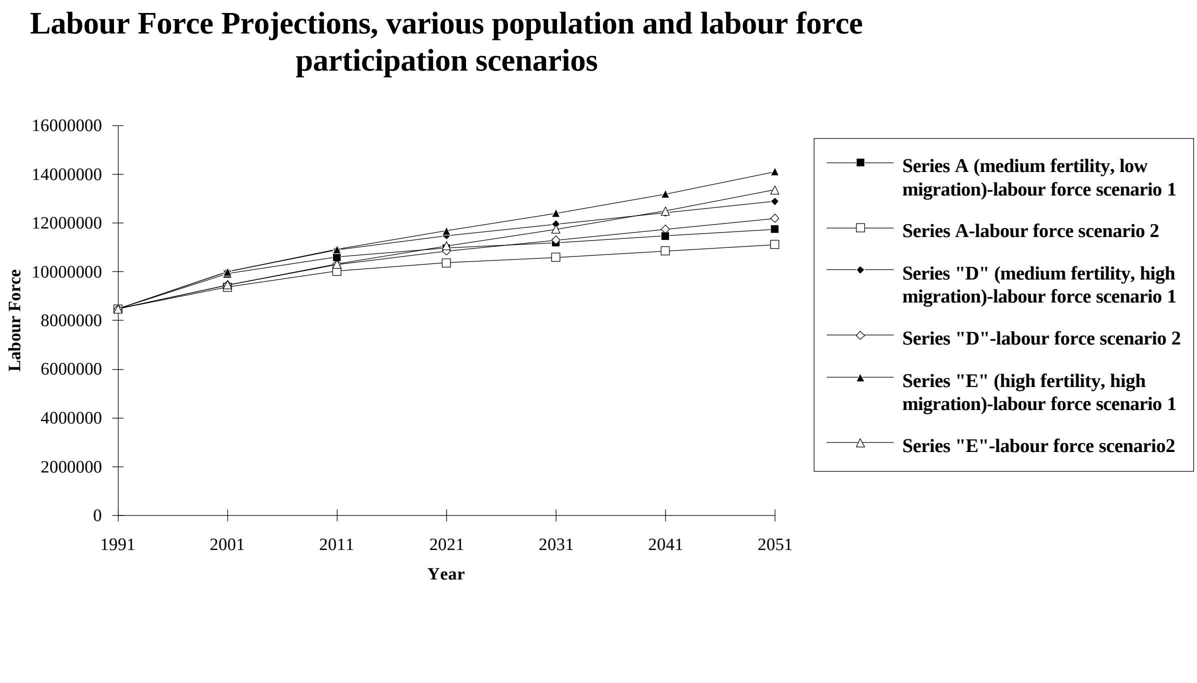
	20 to 24	25 to 34	35 to 44	45 to 54	55 to 59	60 to 64
1985	0.742	0.575	0.614	0.509	0.282	0.119
1990	0.785	0.657	0.720	0.610	0.340	0.160
1995	0.824	0.721	0.768	0.618	0.338	0.277
2000	0.830	0.786	0.810	0.654	0.341	0.276
2005	0.830	0.829	0.842	0.689	0.355	0.289

Men

	20 to 24	25 to 34	35 to 44	45 to 54	55 to 59	60 to 64
1985	0.903	0.946	0.947	0.900	0.771	0.438
1990	0.897	0.940	0.944	0.900	0.751	0.507
1995	0.901	0.914	0.931	0.884	0.664	0.531
2000	0.894	0.906	0.911	0.852	0.618	0.489
2005	0.894	0.895	0.900	0.830	0.588	0.465

Given the strength of the trends, there is necessarily significant uncertainty, particularly by the year 2000 and beyond. For example, the ABS project a participation rate of 0.85 for all women aged 20 to 44 by the year 2005 and 0.76 for ages 45 to 54. Further, the uncertainties in the population figures and the labour force can compound leading to a 'cone of uncertainty'. Chart A below illustrates this.

Chart A



MODELS USED

Population

Previous population analysis by the RIM Task Force has used the 1989 population projections from the ABS augmented with analysis from the PEOPLE v2 demographic model from the United

Nations (PEOPLE, 1990). There were some significant problems with these procedures. These arose principally from artificial periodicity of 5 and 10 years (due to the extrapolation from 5 year grouped data) and significant inaccuracy of population estimates at ages above 75 which are important for estimating Australia's pension costs but less important (regrettably) in Third World countries. To overcome the earlier difficulties and add improved functionality a new population projection model **POPMOD** has been built in house by Mr Bruce Bacon. This is a stand alone model written in SAS with an EXCEL pre-processor. The module enables either selection of standard ABS population projection assumptions, permits modification of any of them or the building from scratch of new assumptions via simple inbuilt procedures. A fuller description of POPMOD is at Attachment B and a complete description in Bacon, 1994.

Retirement Income Models

The Terms of Reference require the RIM Task Force to 'construct state-of-the-art computer based dynamic simulation models, of both an aggregate and individual-based (hypothetical) type'. Microeconomic models known as **tax-benefit models** are the most suitable for this purpose. Such models cover earnings, the accumulation of superannuation, the accumulation of other savings, taxation of earnings and savings and social security entitlements based on marital status as well as income and assets.

The models used by the Task Force comprise both hypothetical models, which cover one individual or a couple or income unit, and aggregate group models. The current individual model is called INDMOD; it projects superannuation, age pension, and tax concessions for individuals and couples, and calculates a cost-benefit analysis comparing present value of benefits to individuals with present value of net costs to Government (Brown, 1993).

The aggregate group model currently used by the task force is a development of the National Mutual Retirement Income Policy Model (RIP). It projects aggregates for superannuation and retirement incomes for Australia using a framework of age by sex cohorts. The model has been substantially updated and enhanced by the Task Force. Part of the development has been the refinement by the Task Force of the analytical framework for considering and presenting results from RIP. Private savings are represented as **annual** increases arising from additional superannuation contributions and interest, net of amounts that would have been saved anyway. To estimate the impact of the SGC we use a counterfactual of the voluntary superannuation and award arrangements that would have pertained without the SGC. The tax expenditure framework is a new one as set out in Brown, 1993[1]. Annual public saving arises as the difference between savings in pension costs and additional tax expenditures compared with the appropriate counterfactual. All quantities are presented in the Charts as percentages of the GDP pertaining to that year of the analysis. This framework was adopted by the FitzGerald Report on National Saving (1993). An example of its direct use to estimate the impact of the SGC is in Chart D below.

While the RIP aggregate model may seem to represent only a totalling over the population of an individual model such as INDMOD, in fact the model is large and intricate. This arises because of the need to handle additional transitions like premature death and disability, early payouts of superannuation on changing jobs, less than full vesting of benefits, the fact that a cohort may have more than one superannuation accumulation, complexity in the Tax and Social Security systems, as

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[1]There are comments on this methodology in the Treasury Tax Expenditure Statement for 1993.

well as demographic and labour force participation changes as discussed above. A fuller description of RIP and its strengths, weaknesses and key assumptions is provided in Attachment C.

The RIM Task Force intends to develop two further models with common code to be called RIMHYPO and RIMGROUP. RIMHYPO, currently being completed, is a hypothetical model which will provide a developmental stepping stone and a test harness for RIMGROUP. It will also provide a model which is faster than INDMOD for analysing multiple hypothetical cases. RIMGROUP will be a group model which will improve upon RIP by allowing separate accumulations for each income decile in each age-gender cohort, by modelling decrements associated with temporary unemployment or exit from the labour force and which will be portable and maintainable because it will be written in SAS.

The sensitivity analyses described below have all been done using RIP with POPMOD providing appropriate input.

SENSITIVITY ANALYSIS

Only some dimensions of the tremendous uncertainty faced in attempting such modelling out some 60 years have been indicated above. There is an unquestionable need for sensible sensitivity testing to ensure that results are relatively robust and not an artefact of the particular parameter values and scenarios chosen: it is not a luxury but a necessity.

It is important that the sensitivity analysis fit the circumstances. Most of the questions being considered by the Task Force are to compare the implications of Policy A with those of Policy B. So the issue is not so much the absolute value of say, tax expenditures or national savings, in fifty years time but whether the relative advantage of one policy over another is robust to a range of reasonable, and internally consistent, views about the future. It considering this it is important to consider also the structure of the model as well as reasonable ranges for parameters. Some earlier sensitivity studies are reported in Gallagher, Rothman, and Brown(1993).

Impact of Immigration Levels

Earlier versions of RIP used the rate of immigration then assumed by the ABS, about 125,000 persons pa. The ABS now has two alternative assumptions; the first has annual net overseas migration increasing from 40,000 pa in 1993-94 to 70,000 in 1999-2000, the second has the increase rising to 100,000 pa by 2000-2001. Under both assumptions the projected migration levels then continue at constant levels.

Table 2 and Chart B present a comparison of the results of running RIP with the new lower migration assumption (the new series A) with the results using the alternative higher migration assumption.

Table 2 Impact of Different Immigration Levels

$ million

	Super assets A	Super assets B	Percent Difference	Pensions A	PensionsB	Percent Difference
1995	195300	195300	0.01	16000	16000	0

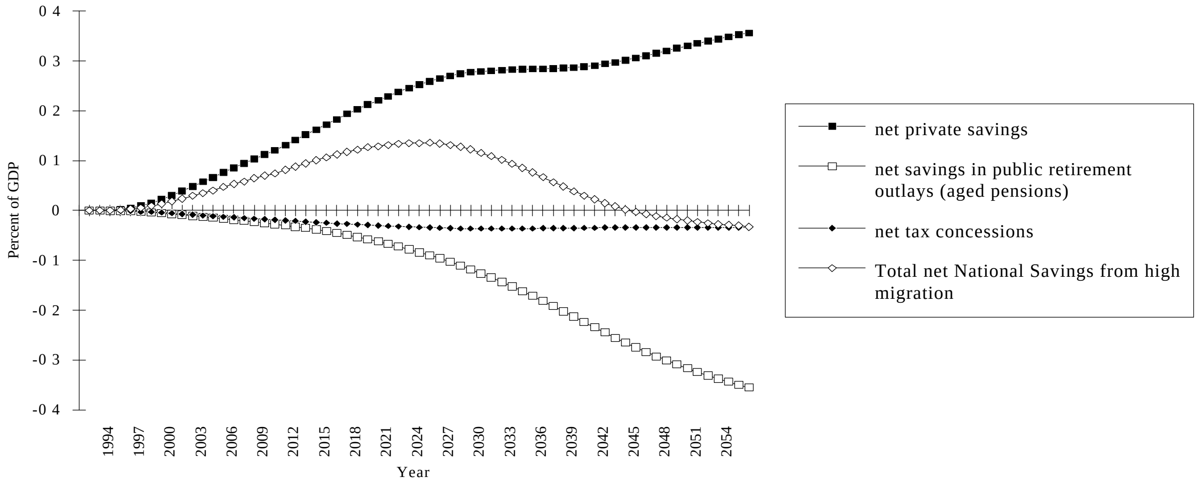
2000	281500	282100	0.2	17600	17700	0.48
2010	509300	515400	1.2	23300	23400	0.62
2020	726100	745400	2.66	32100	32600	1.53
2030	897900	936800	4.33	42100	43200	2.51
2040	1024100	1083900	5.84	48500	50800	4.69
2050	1156800	1240500	7.24	52600	56300	6.95

The Table shows the consistently less superannuation accumulation and lower pension costs associated with lower immigration (indicated as series A).

The Charts below elaborate on these figures. Accepting the lower level of immigration as the base projection, Chart B uses the standard analytical framework developed by the Task Force (as outlined above) and POPMOD population projections to demonstrate the sensitivity of key aggregates to the higher migration scenario. This chart is easy to interpret showing consistently greater annual private saving associated with higher immigration, reflecting principally the larger working population and larger pension outlays which grow to fully offset the initial positive impact on national saving of the increase in private saving.

Chart B

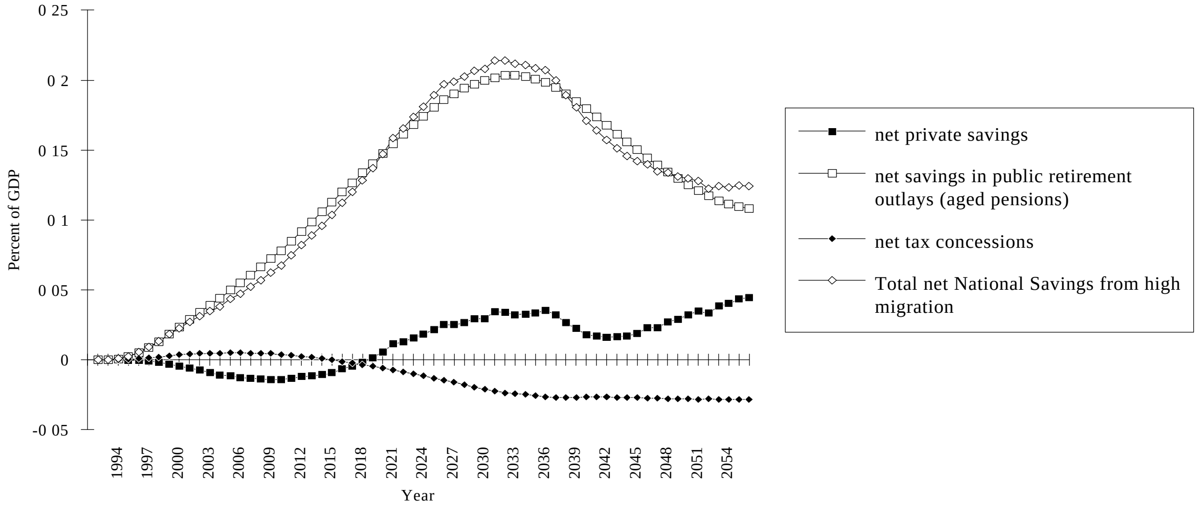
Additional Net Annual National Savings of Financial Assets from High Migration .



However, this chart is an oversimplification because in this analysis the expected change of GDP with changed migration has been ignored. When this is allowed for (at least in an approximate linear way) in Chart C below the interpretation is more complex.

Chart C

Additional Net Annual National Savings of Financial Assets from High Migration , GDP adjusted.



Here there is also additional national saving but this arises essentially because pension costs per capita of working population are lower in the high migration scenario (reflecting the different age structure of migrants). Notwithstanding the inherent difficulty of accurately adjusting GDP as migration levels change, the analysis in Chart C is considered to present a more realistic picture.

Impact of Labour Force Participation

As indicated above the RIP base parameter set has been adjusted to reflect the best available projections of the labour force. Additionally, DEET data (DEET, 1991) on the changing proportion of work which is part time has been used to derive a reduced rate of average wages growth. Because average wages in the model represent the average of both full and part time work and the proportion of part time work is growing, an assumed 1% annual growth in labour productivity translates to an average wages growth of 0.85%. Recent and current unemployment rates have been incorporated and, following some discussion with EPAC, a steady state unemployment rate of 6% has been assumed.
A demonstration of the extent of variation in key aggregates associated with various labour force assumptions is at Charts D to F. Charts D and E compare two runs on the impact of the SGC policy identical except for labour force entry at 20 compared with 25, the earlier RIP assumption. Private saving increases arise from increased superannuation contribution and interest net of amounts that would have been saved anyway comparing specifically with a counterfactual where the voluntary superannuation and award arrangements would have continued without the SGC. Public saving arises because of reduced pension costs offset by additional tax expenditures.

Chart D shows the impact of the SGC using the standard framework. Chart E shows the additional impact arising from the new labour force assumptions. The differences are seen to be substantial reflecting:

- extra contributions made during the age range 20-24, leading also to some extra costs of the tax concessions; and

- a substantial additional build up of superannuation funds and amounts accumulated especially as the additional amounts are accumulated early in a person's career.

Chart D

Additional net annual National Savings from the SGC - New labour Force projections, 20 year old entry to workforce

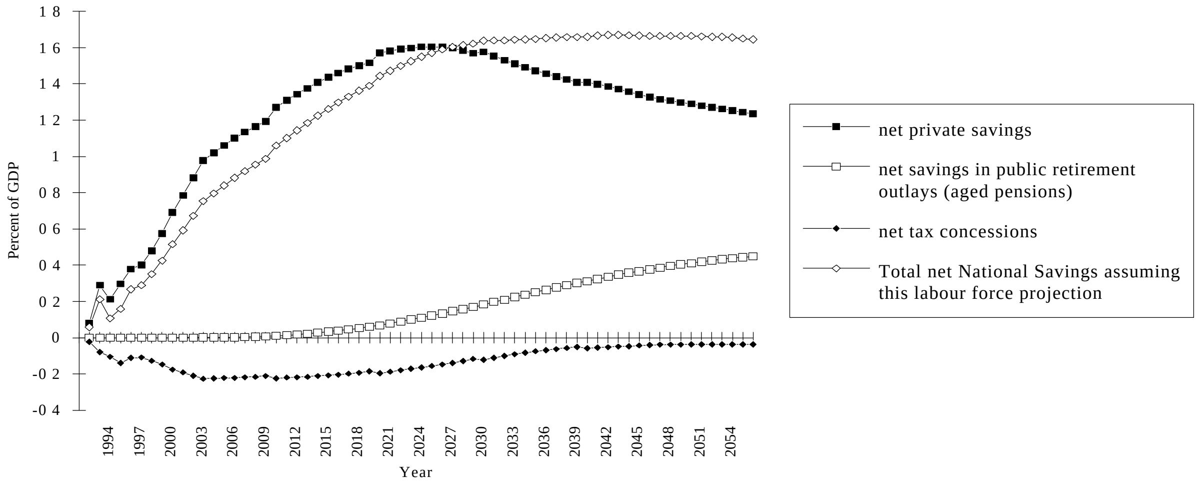
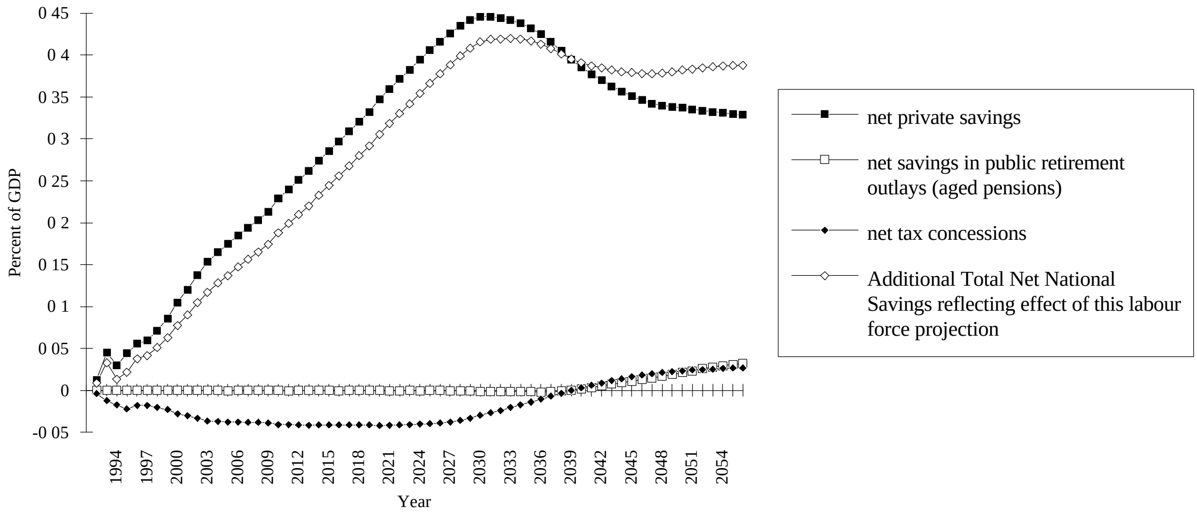


Chart E

Additional Net Annual National Savings compared with previous analysis of impact of SGC, arising from new labour force projections, 20 year old entry to workforce

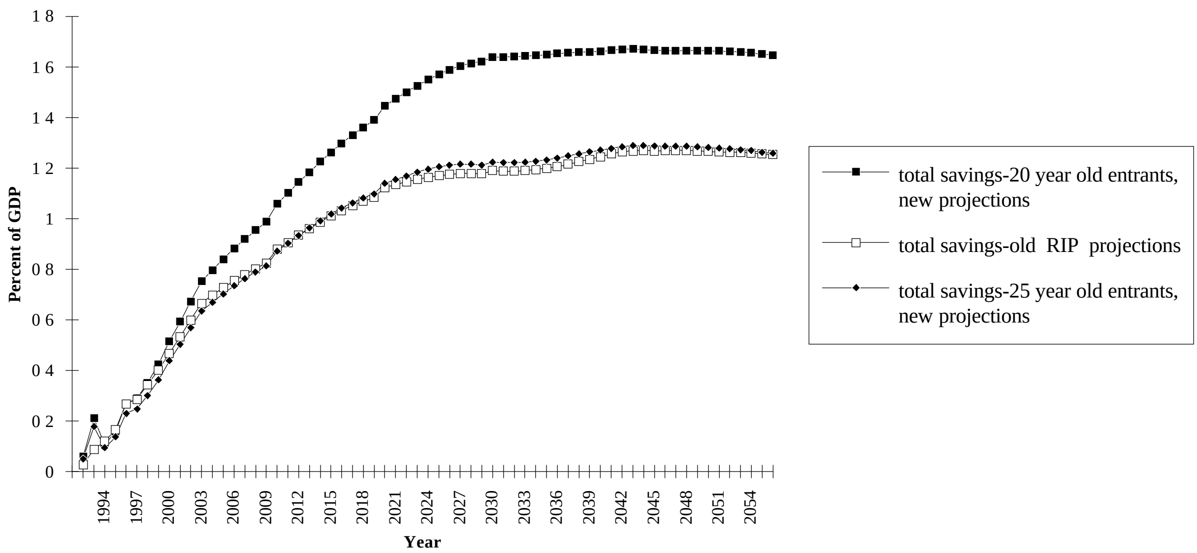


With the additional 20 to 24 year old data the fit to the overall labour force is quite good. While the SGC age limit is 18, we see very limited value in extending labour force entry below the age of 20 given society's trends towards spending longer periods in education and the probable losses of superannuation accumulations through non preservation and lack of vesting by those under 20 (despite the best intentions of the SIS legislation).

Chart F below summarises these differences and difference in aggregates due to a realistic time trend in labour force participation now being included.

Chart F

Sensitivity Analysis - Net annual National Savings from different labour force projections



Impact of Additional Longevity

As indicated above the broad picture of an ageing Australian society is largely inevitable, with aggregate pension costs rising from under 4% of GDP now to some 5 to 5.5% by 2030. The detailed picture will be influenced by our demographic assumptions. The potential importance of mortality rates and the views of some experts have influenced the Task Force to construct its own alternative of an even greater decline in mortality rates at older ages- the 'healthy lifestyles' outlook. This assumes an acceleration of reduction in mortality rate for ages 67 to 85 over the next 10 years over and above the ABS reductions; the continuing improvement then reverts to the ABS trend. Table 3 shows the improved longevity associated with this assumption, alongside the additional longevity implicit in the ABS assumptions . Aggregate population estimates out some 50 years rise by about 1% but importantly by as much as 16% for the population of men over 65. The RIP estimates of additional annual age and service pension costs due to this specific assumption are a rise of 2% in 10 years, 3.5 %. in 20 years and stabilise at about 4%. While these numbers in themselves are not dramatic they are consistent with the additional longevity at age 65 indicated in Table 3. The scale of the impact on key aggregates as a proportion of GDP are shown below in Chart G. The effect on tax expenditures and private savings is negligible and the impact on aggregate savings comes directly through the change in pension costs.

Chart G

Additional net annual National Savings of Financial Assets from assumption of a lower mortality scenario, given implementation of the SGC

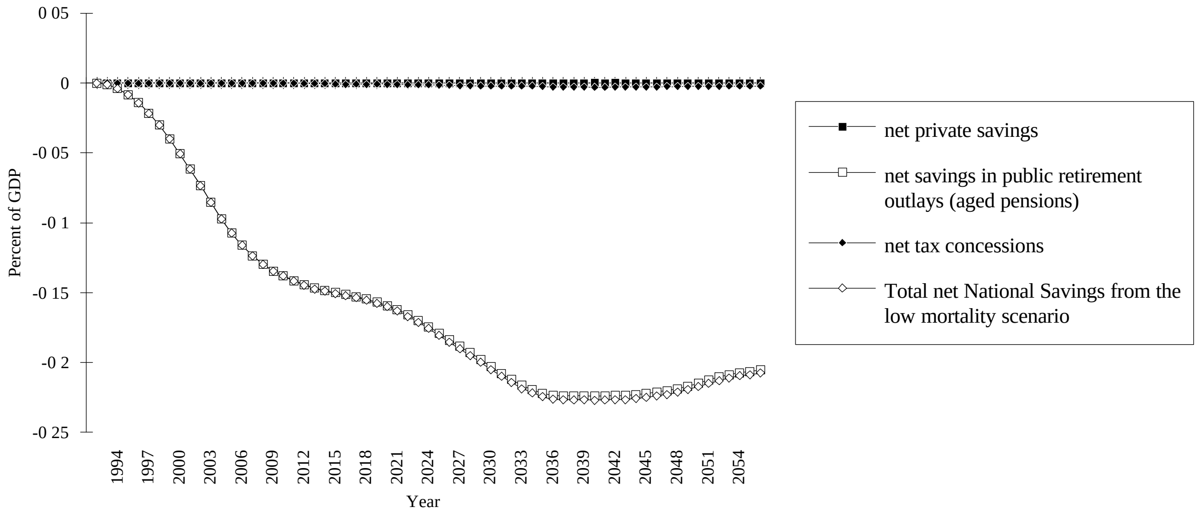


Table 3
Projected Age Specific Expectations of Life

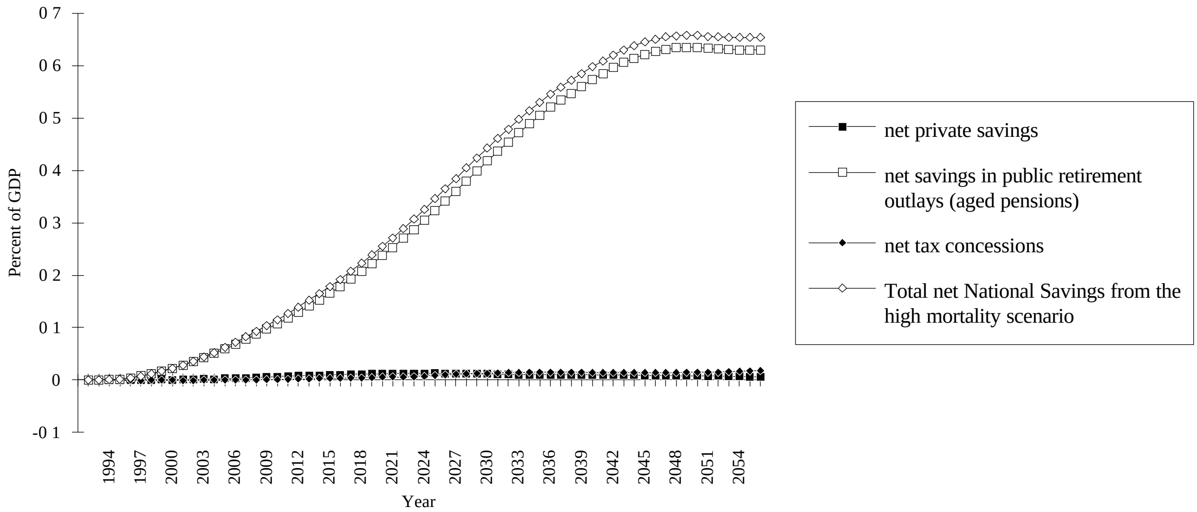
		ABS	RIM variation	ABS	RIM variation
Age	**1992**	**2025**	**2025**	**2050**	**2050**
Males					
0	74.5	78.4	79.3	79.7	80.6
20	55.6	58.9	59.9	60.1	61.0
65	15.5	17.4	18.5	18.2	19.3
85	5.0	5.8	6.0	6.1	6.3
Females					
0	80.4	83.7	84.6	85.1	85.9
20	61.2	64.1	65.0	65.3	66.1
65	19.2	21.4	22.3	22.4	23.2
85	6.1	7.4	7.5	8.0	8.1

Another Alternative Mortality Assumption

A further study the impact of alternative mortality assumptions has been done to indicate the substantial additional pension costs implied by the marked additional longevity implicit in the ABS assumptions, or to indicate the scale of savings if the predicted improvements do not eventuate. Chart H below shows the effects of assuming that mortality rates remain unchanged at 1993 levels (an extreme assumption solely for the purposes of sensitivity analysis). There is a large potential increase in national savings almost entirely due to substantially reduced costs of age and service pensions.

Chart H

Additional net annual National Savings of Financial Assets from assumption of a high mortality scenario, given implementation of the SGC



A further aspect of sensitivity to older age cohorts has been studied. Normally in RIP persons exit the view of the model at age 90. A sensitivity analysis has been carried out extending this age to 100. Changing the age of exit makes a negligible difference to the total assets accumulated by superannuation funds. The change in the estimates of the age pension costs range from about 2% now to 8% in 2050, with the higher pension costs being estimated in the age 100 case. However the difference is similar for both the SGC and pre-SGC cases and therefore the standard analysis of the impact of the SGC is not appreciably affected. Accordingly to keep the model to a manageable size it was decided that the age 90 cut off was adequate and should remain as the base run, except where pension costs are the focus of the study.

ESTIMATING SUPERANNUATION ASSETS IN THE YEAR 2000 -

A BROADER SENSITIVITY ANALYSIS

As the RIP model has the ability to provide information on key aggregates for Australia there is some pressure to provide such estimates even though, as explained above, the principal purpose of the model is for policy analysis and the comparison of alternative policies. There has been a lot of interest in the aggregate level of superannuation assets for Australia as a whole in the year 2000. An earlier estimate which has been widely quoted is that the level of assets will be over $600b in year 2000 prices (Keating, 1989). One of the factors leading to this high estimate was the much higher rates of inflation then expected to apply up to the year 2000.

The RIP model has been run specifically to provide an alternative estimate together with a range of uncertainty. Clearly, as well as the uncertainties in demography and labour force described above, the level of assets will be strongly influenced by the rate of return on assets and the inflation rate. Accordingly a range of reasonable rates of return, inflation rates and wage rate increases have been run through the RIP model. Based on these results we project the aggregate assets held by superannuation funds in the year 2000 to be in the range $260b to $300b in constant 1994 prices, or in the range $320b to $380b in year 2000 prices. In coming to these values the model was made as consistent as possible with Treasury economic projections to the year 2000. It is emphasised that these values for asset holdings are projections based on a range of plausible economic parameters and are not predictions. Table 4 presents our estimate of current flows into and out of superannuation funds and the corresponding flows in the year 2000 in current prices and for the higher end of the projected range.

Table 4

Estimated Growth of Total Superannuation Assets

$ million

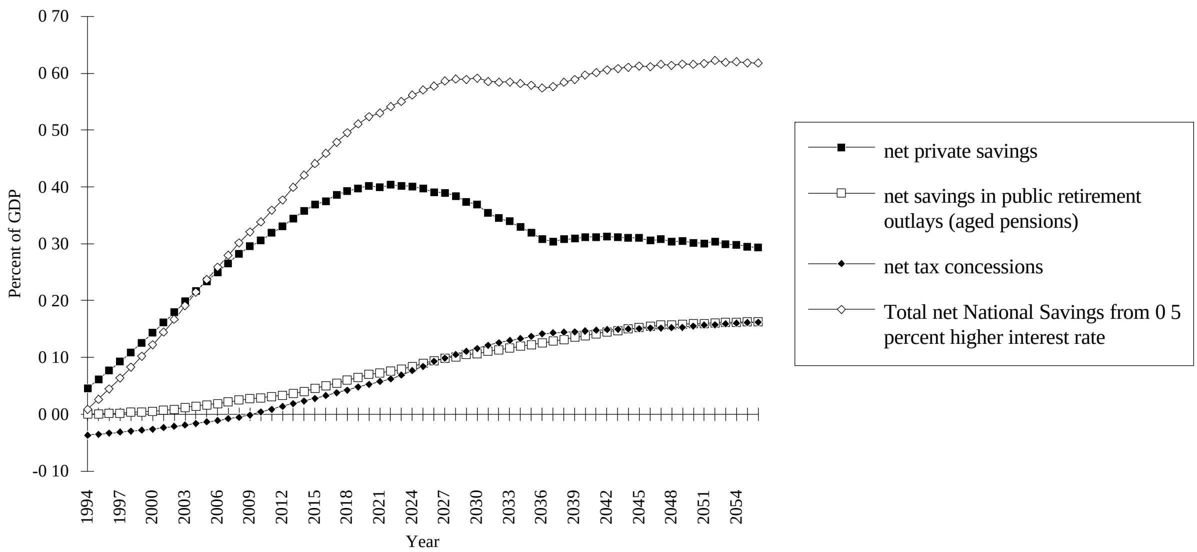
Year	Contributions	Contributions Tax	Payouts	Earnings	Earnings Tax	Total Assets
1994	$19,400	($2,100)	($9,700)	$13,400	($900)	$183,700
2000	$31,700	($3,600)	($14,000)	$26,800	($1,900)	$366,500

LONG TERM SENSITIVITY TO EARNINGS RATES

To place the sensitivity studies in respect of population and labour force reported earlier into perspective, it is worthwhile to consider the long term impact on the principal aggregates of a consistently higher or lower interest rate earned by superannuation funds, assuming that the SGC is fully implemented. Chart I below shows the substantial increase in national savings corresponding to a consistent additional half a percent real return. There is very substantial increase in private savings due to greater accumulation and also savings in pension costs and over time in tax expenditures as more earnings tax and lump sum taxes are paid. The overall impact is greater than most of the demographic variations considered. It is important to note that this analysis is for a given policy (the SGC); if the question is of policy A compared with policy B the perceived impact will be lower because the analysis for both policies will assume the higher rate.

Chart I

Additional net annual National Savings of Financial Assets from half a percent higher real interest rate earnt by Superannuation Funds.



CONCLUSIONS

Major population and labour force changes have been taking place in Australia. Projecting the likely course of these trends in detail over a time scale exceeding 50 years is a far from trivial task but, is in fact, an essential building block for the modelling work of the RIM Task Force. To facilitate this work and particularly to give greater accuracy in estimating the population at higher age ranges, a population projection model POPMOD has been built.

After drawing upon the best available work and expertise in projecting demographic and labour force trends, considerable residual uncertainty remains. Accordingly, sensitivity analysis is seen not as a luxury but as a necessity. The extent and details of such analyses are likely to vary depending on the particular aggregate(s) which is/are the focus of a particular study.

The extent of perceived sensitivity depends to a significant extent on the analytical framework that is used. Much of the work of the RIM Task Force is involved in comparison of alternative policies and an appropriate and quite complex framework for this has been developed and used for example in the FitzGerald Report on National Saving. Within this framework all key aggregates are divided by the GDP figure for the particular year. Accordingly there is less perceived sensitivity to, for example, a higher projected population level; while the higher population will necessarily involve higher levels of superannuation and national saving, it will also be associated with higher level GDP and the effects to some extent cancel out. Even within this framework the results presented above show considerable sensitivity to the age of entry to the workforce. Principally reflecting this the current base RIP runs indicate a higher impact on national savings than the results published in the FitzGerald Report[2].

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[2] Reflecting more recent research, as yet unpublished, the current base run also has a lower savings offset factor - 0.3 compared to 0.5 assumed in the FitzGerald Report. Additionally a higher dissipation of funds accumulated is assumed; this is a conservative assumption reducing the indicated impact of the SGC. The results of a recent base were published in Appendix E of the Twelfth Report of the Senate Select Committee on Superannuation, May 1994.

The other way to consider RIP output is directly through the projections of the aggregates themselves. As indicated above the shortage of models for superannuation and related aggregates for Australia means that such results are of considerable interest. The sensitivity of such results is greater and it is also important to consider a wide range of economic parameters, such as the earning rate of superannuation funds, additional to the demographic and labour force parameters. In presenting such results it is essential that a reasonable range of uncertainty be given together with the best estimate. This has been illustrated in the paper by the new estimates for the level of superannuation assets in the year 2000 and also by the influence on estimated pension costs of trends in mortality rates and age of exit from the RIP model.

Sensitivity analysis should concern itself not just with variations to model parameters but also with the structure of the models themselves. Because of pooling effects in RIP, migrants are merged in with all other Australians of the same age and sex and assumed to share in that superannuation pool for the cohort. There must therefore be less than full sensitivity to changing migration rates and age patterns. While the model assumes reasonable relationships between economic parameters, the modelling is essentially restricted to the household sector, there is no direct linkage to economy wide models and therefore no full consideration of all possible feedbacks through the economy.

Comprehensive sensitivity analysis should also consider what happens when a number of parameters move together, not just each parameter in isolation. Fairly obvious interrelationships have been allowed for in the sensitivity analysis, such as correlations between inflation rates and rates of investment return, average wages and annuity factors. Further, to a first approximation small perturbation effects should be additive. However, a better approach might be to develop and run four or so complete and internally consistent scenarios through the model as part of the standard process of examining policy options; for example the scenarios may reflect a long run of boom economic times or a long run of lean times.

Overall, the aggregates produced by the RIP model with its associated analytical framework have been shown to be quite robust to a range of views about the future, thus strengthening the perceived value of the model as a policy tool. It also has the capacity to provide a most likely value and a range of uncertainty for some important Australian aggregates of interest such as projected asset holdings of superannuation funds and age and service pension costs. The new aggregate model of the Task Force (RIMGROUP) now under development, will maintain the strengths of RIP and add to them through an improved capacity to do distributional analysis based on lifetime income groupings, inclusion of comprehensive tracking of all social security payments and incorporation of the results of new parameter research such as presented by Colin Brown at this Colloquium (Brown, 1994).

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ATTACHMENT A

Task Force on Retirement Income Modelling

Revised Terms of Reference
as agreed at Steering Committee meeting of 28 April 1994

General

To develop a capacity for modelling the impact of retirement income policies over the next half century (see attached Press Release) and to provide advice to departments and Ministers as required on policy options affecting retirement incomes.

Specific

1. The RIM Task Force will construct state-of-the-art computer based dynamic simulation models, of both an aggregate and individual-based (hypothetical) type capable of providing quantitative answers to the following issues:

1.1 The impact over a fifty year time horizon of various retirement income policies (in the taxation, social security, labour market and superannuation regulation areas) on:

- the quantum and distribution of retirement benefits
- the age pension system and the social security system generally
- the quantum and distribution of superannuation tax concessions
- the fiscal balance
- superannuation assets
- private sector saving
- national saving
- workforce participation and retirement patterns

1.2 The sensitivity of model results to key parameters, including:

- demographic variables
- retirement benefits commutation patterns
- lump sum dissipation patterns
- fund earnings rates
- key macroeconomic and microeconomic variables
- the retirement age decision
- contribution/earnings patterns over the life cycle
- relevant tax, superannuation and social security parameters

2. The RIM Steering Committee (comprising officers of the Treasury, the Department of Finance, the Department of Social Security, the Australian Government Actuary, Dr Vince FitzGerald, Professor Adrian Pagan and Professor John Piggott) will approve model specifications and development timetables, and regularly review progress based on reports from the Task Force and its user groups. The user groups will consider the technical aspects of the design, validation, documentation and implementation of the RIM models.

3. While the development of the models is proceeding, the Director of the Task Force will be required to ensure that each of the Departments referred to in 2. above has access to confidential

advice on the longer term implications of policy options under consideration, on the basis of the models as they stand, together with adequate explanations of the capability and limitations of the models as at the time the advice is provided.

4. The models will be fully documented on an ongoing basis, and the Director of the Task Force will be required to ensure that at appropriate stages of the models' development, and on completion of the development work, each of the Departments referred to in 2. has full access to models and associated data and training in the use of the models.

5. The Task Force will have regard to the relevant academic and official work in the retirement incomes area. It will be expected to establish contacts with others working in the area, including overseas, and to publish details of modelling methodologies employed in its work.

6. The progress of the Task Force will be reviewed at the end of its first year of operation when these Terms of Reference may be amended.

Notes

It is noted that the Task Force will have access to the National Mutual retirement Income Policy Model on terms set out in an existing agreement of 1 May 1992 between National Mutual Life Association and the Department of Finance (copy attached) and will therefore be responsible for ensuring that the terms of the agreement with National Mutual are complied with.

Attachment B

POPULATION PROJECTIONS: POPMOD

To overcome the earlier difficulties and add improved functionality a new population projection model POPMOD has been built in house by Mr Bruce R. Bacon. This is a stand-alone model in SAS such that the population projections can be automatically picked up by the RIMGROUP model. The module enables either selection of standard ABS population projection assumptions, modification of any of them or the building from scratch of new assumptions via simple inbuilt procedures. Although the primary function of the population module is to drive RIMGROUP, it has the capacity to accept externally defined assumption matrices and the ability to produce text based output for use in non SAS based models such as RIP.

In May 1994, the ABS released updated population projections from 1993 to 2041 (ABS, 1994). These projections form the basis for the RIM population projections. In particular the most likely projection, Series A, is used as the reference population projection against which alternate results are benchmarked.

The population module runs as a preprocessor to RIMGROUP. The module runs in two modes:

- a selection of ABS defined projections from the ABS “Population Projections: 1993-2041” as fixed data sets; or
- a population generating procedure structured around the ABS cohort-component methodology. This procedure can closely reproduce the ABS projections or the user can build a new population data set based on user defined parameters.

The population generating method, detailed in at the end of this Attachment, starts with a base population for each sex by single years of age and by applying user controlled assumptions on fertility, mortality and net overseas migration, advances the projections year by year.

The base population as at June 30 1993, is published in "Estimated Resident Population by Sex and Age" (ABS 3201.0). Because the RIMGROUP model can be started before 1993, historic population datasets will be maintained for as far back as necessary.

The fertility generating procedure is consistent with the ABS methodology:

- the Total Fertility Rate (TFR) linearly declines to a user defined level which is maintained constant after that;
- the implied growth rate is applied to the ABS base age-specific fertility profile for the year 2002;
- linear interpolation of age-specific fertility rates; and
- manual adjustment of the age-specific fertility matrix if necessary.

The fertility assumptions are controlled by specifying:

- the level to which total fertility is to decline;
- the year from which fertility is to be held constant; and
- a manual adjustment to the generated age-specific fertility for any year and age-group.

The module outputs the final age-specific fertility matrix.

Accuracy

POPMOD closely benchmarks with the ABS Series A projections to an error of less than 0.0001 per cent.

Details of POPMOD

General demographic framework

For each year

$P^{i+1} = P^{i} * (1 - Q^{i}) + X^{i}$ $\qquad i$ = age $\Rightarrow$ 0 to n

or

$P^{i+1} = P^{i} - D^{i} + X^{i}$

and

$M^{i} = a^{i} * P^{i}$

$F^{i} + M^{i} = P^{i}$

where P^{i} = population at age i

P^{i+1} = population at age i + 1 in the next year

Q^{i} = death probability at age i

X^{i} = net overseas migration at age i

D^{i} = deaths at age i

M^{i} = no of males of age i

a^{i} = proportion of males in population of age i

F^{i} = no of females of age i

Births $P^{0} = \sum_{i=a}^{b} F^{i} * f^{i} / 1000$

where f^{i} = age group specific fertility per 1000 women

a = start of child bearing age group

b = end of child bearing age group

and Total Fertility $Tf = 5 * \sum_{i=a}^{b} f^{i}$ for 5 year groups

For the working model this general framework must be extended to allow for flow averaging and open end point correction.

The operational model becomes for year *t*:

$$P_{t+1}^{i+1} = P_t^i * (1 - Q_t^i) + \tfrac{1}{2} X_t^i * (1 - \tfrac{1}{2} Q_t^i) + \tfrac{1}{2} X_t^{i+1} * (1 - \tfrac{1}{2} Q_t^{i+1}) \qquad \text{for age } i = 0 \text{ to } 98$$

where X is split to capture age effects and $\tfrac{1}{2} Q$ is used to capture arrival time effects.

For the maximum age group

$$P_{t+1}^n = P_t^n * (1 - Q_t^n) + P_t^{n-1} * (1 - Q_t^{n-1}) + X_t^n * (1 - \tfrac{1}{2} Q_t^n) + \tfrac{1}{2} X_t^{n-1} * (1 - \tfrac{1}{2} Q_t^{n-1})$$

where n = the age group100 +

Births are calculated by:

$$B_t = \tfrac{1}{2} \left(\sum_{k=15-19}^{45-49} F_t^k * f_t^k + \sum_{k=15-19}^{45-49} F_{t+1}^k * f_{t+1}^k \right) \qquad k = 5 \text{ year age groups}$$

giving the zero aged population:

$$P_{t+1}^0 = B_t * (1 - Q_t^b) + \tfrac{1}{2} X_t^0 * (1 - \tfrac{1}{2} Q_t^0)$$

where Q^b = the probability of death at birth

Male births $= \frac{105\,5}{205\,5} * B_t$ and female births $= B_t -$ male births

Deaths are calculated by:

$$D_t^0 = B_t * Q_t^b$$

$$D_t^{i+1} = \tfrac{1}{2} (P_t^i + \tfrac{1}{2} X_t^i) * Q_t^i + \tfrac{1}{2} (P_t^{i+1} + \tfrac{1}{2} X_t^{i+1}) * Q_t^{i+1} \qquad \text{where } i = 0 \text{ to } 98$$

$$D_t^n = \tfrac{1}{2} (P_t^{n-1} + \tfrac{1}{2} X_t^{n-1}) * Q_t^{n-1} + (P_t^n + \tfrac{1}{2} X_t^n) * Q_t^n \qquad n = 100+$$

for all ages

$$D_t = P_t - P_{t+1} + B_t + X_t$$

Note: The ABS adjusts deaths rates in the first year to capture the dispersion of mortality in the the first year of life by adding $\frac{factor}{1 - factor} * (P_t^0 + \tfrac{1}{2} X_t^0) * \frac{Q_t^b}{1 - Q_t^b}$ to D_t^0 and subtracting it from D_t^1, where $factor = \frac{117}{883}$ for males and $\frac{120}{880}$ for females.

ATTACHMENT C

The National Mutual Retirement Incomes Policy (RIP) Model

The Retirement Incomes Policy Model (RIP) is a model to estimate stocks and flows of superannuation funds and the impact on savings and costs to the Government's budget of various retirement income policy options. It was originally developed by National Mutual Operations Research and made available to the Retirement Incomes Modelling Task Force. The Task Force has substantially developed the model and used it for policy analysis.

The RIP model is based upon *person cohorts* (people of common sex and age) which are aged a year at a time and their superannuation benefits accumulated taking account of parameters such as wage levels, employment rates, inflation and rates of return on assets. At retirement the detailed interaction with the Tax and Social Security systems is accounted for.

The model incorporates three major phases:

- a population phase based on ABS or POPMOD data which projects the total Australian population by age and sex for each year in the future, allowing for births, deaths and immigration;

- a superannuation dynamics phase which takes output from the population projection and projects:

  - the number of people employed in each year;

  - the number of people in each type of superannuation fund modelled (public and private sector, categorised by the type of superannuation contributions concerned); and

  - the numbers retired because of death, disability or age retirement for each person cohort for each year of the projection; and

- an accounting phase which uses the outputs of the first two phases of the model to keep track of the total superannuation assets of each person cohort, allowing for contributions, earnings, benefit payments, possible dissipation on change of job and tax. It calculates the relevant cash flows for each person cohort in each year and stores the results. On retirement, the model splits the accumulated superannuation benefits of each age cohort up according to an income distribution and calculates the tax payments arising, the age pension payable, and the continuing retirement income stream from superannuation.

Aggregating the results in each year across all the person cohorts allows calculation of total stocks and flows for the Australian population within the model. The model also estimates the tax expenditure on superannuation for each year.

<u>Recent Developments</u>

Key developments of the model have been:

- An improved estimation of tax expenditures, using extra model runs initially but upon further development through incorporation of additional accounts.

- The facility to model the accumulation of non superannuation assets endogenously, with accumulation rates as a function of age, sex and time (final estimates for the rates are not yet available). There is also an additional parameter specifying the elasticity of substitution between changes in superannuation saving and non superannuation financial savings.

- A considerable extension of the time scale of the modelling to 2056 (rather than 2029).

- Review and revision of the parameter set, particularly in relation to the population, labour force and tax rates.

Strengths and Weaknesses

The strengths of the RIP model are:

- its completeness, particularly the detailed modelling of superannuation processes including different account types and preservation and vesting rates and the modelling of disability and death benefits as well as age retirement.

- the very extensive parameter set which gives the facility to access a wide range of policy options without modifying the model's structure.

The weaknesses of the model are seen as:

- the very limited ability to allow for variation within an age, sex cohort:

  - Specifically, the salary distribution is exogenously supplied (4 points or 11 points) and this limits the accuracy of derived distributional information and the accuracy of the interactions with the complex Social Security income and assets tests and the tax system;

  - the model does not include a married, not married variable; and

  - similarly there is effectively no predictive ability to allow for distribution arising from variability in labour force experiences.

- the 'tontine' effect: even if a member of a person cohort joins the group later eg. a migrant, they share equally upon retirement with all others in the group. This can also be a significant problem, where for a new policy, a new group start contributions at a specified time and are mixed in with existing contributors.

- the model is deterministic and does not allow for stochastic variations in outcomes (due to random fluctuations in, say, earning rates).

- the unusual object oriented language Smalltalk in which the code is written. While this is intrinsically a powerful and versatile modelling language it is:

- not well known and takes a lengthy period to master; and

- uses extensive computing resources and time.

Apart from the last point, to a significant extent the weaknesses of RIP are intrinsic to grouped models. Finer scale subdivision of the group is required and this is envisaged in RIMGROUP, a model being designed by the Task Force. Alternatively, dynamic microsimulation techniques can be used which focus on tracking the experiences of individuals or very small groups (but this is a very large and demanding development task).

<u>Base Parameter Assumptions</u>

Population: Rates underlying the new ABS Series A (projected through POPMOD model).

Economic: Current and recent rates projected from 1995 on at:

- 3% inflation;

- 7% earnings rate for superannuation funds (after costs but before tax);

- 3.85% growth in average Salaries and AWE (ie 1 % productivity growth adjusted for changing proportion of part time work).

Taxation

- Current income taxation rates, changed in 1996 to Government indicated rates, and indexed thereafter.

- 15% earning tax on superannuation funds - assumed to be an effective 7% rate.

Savings Replacement

- 30% of available funds released in the absence of compulsory and concessional superannuation would be saved;

- earnings on these alternative savings to superannuation taxed at 25% marginal rate .

Contributions

- As the SGC contribution rate rises the voluntary employer contribution rate is assumed to drop correspondingly ie the SGC replaces existing voluntary employer arrangements and is not additional to them.

Retirement

- Pension rates indexed to AWE and the limits for income and assets tests indexed to CPI.

- Retirement stream comprises 20% non indexed annuity and 80% conversion of lump sum to simple interest income stream earning 6 1/2% pa. Dissipation of the free area for lump sum tax is assumed.