Modelling Retirement Income in New Zealand

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This paper presents a model created to project the fiscal costs and selected distributional impacts of retirement income policy in New Zealand. Aggregate fiscal costs to the government are currently projected through Treasury's Long-term Fiscal Model. However distributional impacts of retirement income in New Zealand have not had the same level of attention.

A microsimulation model is introduced which evaluates both the fiscal costs and distributional impacts of government provided retirement income, while extending the range of future policies that can be evaluated. The model provide an income component that enhances and complements existing demographic and economic modelling.

J.E.L. CLASSIFICATION
KEYWORDS Retirement Income; Quantitative Methods

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1. Introduction

In this paper, a model is introduced which provides a framework for evaluating both the fiscal costs and distributional impacts of retirement income. The model uses previous work from Ball & Creedy (2012) to provide an income component that enhances the existing demographic and economic modelling used to project retirement income in the Long-term Fiscal Model. Using a microsimulation approach this also allows detailed disaggregation of fiscal measures and distributional analysis, beyond what has been previously available for New Zealand.

New Zealand, similar to most developed countries, is experiencing a structural demographic shift due to lower fertility and increasing life expectancy. New Zealand Superannuation (NZS) is projected to be a major driver of the future fiscal pressures. This is driven by both a rate structure that under current legislation will increase effectively in line with wages and an increasing proportion of the population receiving NZS as life expectancy increases. The aim of this paper is to extend current modelling in three ways. Firstly, an income component is added to existing demographic and economic modelling which allows evaluation of the fiscal impact of changes to the financing of NZS through, for example, a hypothecated payroll tax. Secondly, by using a microsimulation approach a broad range of transmission mechanisms and responses can be modelled. Finally, detailed distributional implications of policy change can be analysed in a way which is internally consistent with the aggregated fiscal costs.

Retirement income in New Zealand has many components, which have been covered in previous and ongoing work such as Preston (2012). The model introduced in this paper is a cohort based microsimulation model, with the cohorts based on birth year and gender. Demographic variables beyond what have been considered in the context of retirement income policy projections,[1] such as years of education and couple formation, have been incorporated into the modelling methodology. The demographic variables are linked to a consistent framework to project income, which is also linked to provide mortality projections which depend on demography and income for the individual. The microsimulation approach provides a framework which can be extended to include further variables of interest, while allowing detailed disaggregation of the drivers of retirement income outcomes at an individual level.

The structure of the paper is to introduce the current state of government policy related to retirement income in section 2. A high-level overview of the model is provided in section 3, which covers how the remaining sections of the paper have been integrated into a coherent modelling framework. Section 4 covers the demographic projections used in the model, which are common to both the Long-term Fiscal Model and the modelling framework covered in this paper.

Section 5 covers education, which is an important factor for determining lifetime income and mortality differentials within a cohort. Couple formation is included in section 6 because of the redistributive impacts that couple formation has on retirement income between males and females. Section 7 describes the approach used to construct income profiles for cohorts, which allow for the quantification of the impact that income-linked policies, such as compulsory private savings, will have on fiscal costs and distributional measures.

Differential mortality is considered in section 8, which reviews the evidence for different mortality rates based on demographic variables such as education and income. This is incorporated into an innovative modelling approach for differential mortality. Section 9 concludes by presenting a selection of applications that the model has already been used for.

2. Retirement income policy as at 2012

This section aims to set out current retirement income policy to frame future policy options that have the potential to significantly reduce the fiscal cost of New Zealand Superannuation (NZS). A more comprehensive history of retirement income in NZ can be found in Preston (2012). The three areas we are primarily interested in are New Zealand Superannuation (NZS), the New Zealand Superannuation Fund (NZSF) and Kiwisaver.

2.1. Current NZS legislation

A more detailed overview of the current state of NZS is presented in Ministry for Social Development (2013). NZS is governed by the New Zealand Superannuation and Retirement Income Act 2001.[2] There are some

[1] A majority of the work projecting fiscal costs related to retirement income policy in New Zealand is based on work from the New Zealand Treasury, for example Rodway & Wilson (2006), Kirkup, Kengmana, Ball, Brook, Coleman & Law (2012).

[2] `http://www.legislation.govt.nz/act/public/2001/0084/latest/096be8ed80837601.pdf`

exceptions to the points below which are covered in the relevant legislation. From a modelling perspective the important points are:

- Available to everyone who attains the age of 65 and meets a residency requirement.[3]
- The after tax[4] married couple rates are adjusted upward each year with the annual growth of the December quarter Consumers Price Index (CPI), while remaining within 65%[5] and 72.5% of the Average Ordinary Time Weekly Earnings (AOTWE).[6] NZS rates can never be decreased.
- Differential rates are applied based on household structure, for instance a Single Living Alone will receive 60% of the married couple rate.
- NZS is universally provided to those meeting the eligibility requirements.

2.2. New Zealand Superannuation Fund

The NZSF was established was established to prefund future NZS liabilties with contributions made out of general taxation. The management and administration of the NZS Fund is done by an independent Crown entity called the Guardians of New Zealand Superannuation.

Modelling the NZSF is largely ignored in the model contained in this paper. However for options involving a hypothecated payroll tax used for communal funding of NZS, parameters such as the projected rate of return from the NZSF are used. More information about modelling the NZSF can be found in New Zealand Treasury (2009).

2.3. KiwiSaver

KiwiSaver is a voluntary private savings scheme that began operations in 2007, primarily through the passing of the KiwiSaver Act in 2006.[7] The high participation rate of KiwiSaver means that it has the potential to change the distributional outcomes in retirement income. KiwiSaver settings have varied since the scheme started,[8] so a high-level summary of the key features is provided below, without reference to specific parameters.

KiwiSaver has auto-enrollment for people starting new employment between the ages of 18 and 65, with the ability to opt out. New members are eligible for a government kick-start, an initial deposit into the KiwiSaver account. Members of KiwiSaver make contributions at self-selected rate which are matched by their employer (if applicable) up to rates specified in legislation. The government also provides contributions in the form of a tax credit.

Accounts for KiwiSaver are managed by private sector "KiwiSaver providers". Providers can be selected by the individual, with the ability to change provider at any time. The providers invest the funds on behalf of the members to obtain a return, deducting any relevant taxes and fees, which determines the final balance of the

[3] No person is entitled to New Zealand superannuation unless the person is a NZ resident as of the date of application, has spent 10 qualifying years in NZ since age 20 and 5 qualifying years in NZ since age 50.

[4] Applied at the 'M' tax code, see Tax Administration Act 1994 `http://www.legislation.govt.nz/act/public/1994/0166/latest/DLM348343.html`

[5] This has been set at 66% by recent governments, however this is not included in legislation.

[6] The AOTWE is the amount a worker would earn if they worked a full 40 hour week at the average hourly wage.

[7] `http://www.legislation.govt.nz/act/public/2006/0040/latest/DLM378372.html`

[8] There have been 22 versions of the KiwiSaver Act as at January 1st 2013. One of the most significant changes since the introduction of the KiwiSaver Act was the Taxation (Urgent Measures and Annual Rates) Act 2008 which changed the maximum employer contribution to 2%, see `http://www.legislation.govt.nz/act/public/2008/0105/latest/DLM1764914.html`.

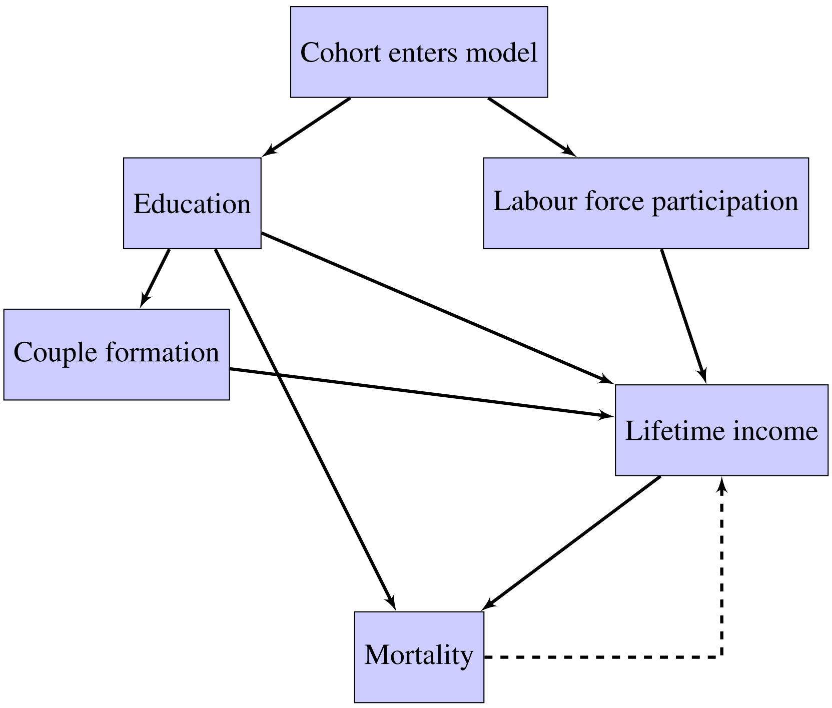
KiwiSaver account. KiwiSaver accounts are not guaranteed by the government, with investment risk remaining with the individual.

3. Model overview

The model introduced in this paper is a cohort based microsimulation model, with the cohorts based on birth year and gender. It has the ability to generate demographic variables, such as labour force participation, years of education and couple formation. The demographic variables are linked to a consistent framework to project income, which is also linked to provide mortality projections which depend on demography and income for the cohort.

The model is formed by linking modules designed to cover each of the variables we cover in the subsequent sections. The dependencies between modules are shown by directional arrows in Figure 1.

Figure 1. Overview of the model



Within Figure 1 the bold arrows represent relationships to determine mortality, whereas the dashed arrow represent the relationship after mortality has been determined. With the various relationships between the components explained in subsequent sections, we have designed our framework to first model an intermediate lifetime income in the absence of mortality, so mortality differentials are based on the expectation of lifetime income and educational attainment. After this mortality is used to arrive at the final lifetime income used in the model. This approach is explained further in Section 8.

4. Demographics

Demography is a key component of any retirement income model. To the extent that many of the people who are considered in the modelling are alive today it is also one of the more certain components. The demographic assumptions are based on the Statistics N.Z. population projections[9] and the Labour Force projections.[10] These projections have been extended to 2110/11 to allow enough time for some of our options to reach steady state. We have also obtained customised data from Statistics N.Z. for the survival rates and expected remaining years of life. The assumptions underlying the demographic projections from Statistics New Zealand are detailed in Bascand (2012).

The model is based on projecting cohorts through time, and the population data aggregate the 90+ age group for females and males, so we have imputed population by single year of age up to 125. This is used to derive the projected fiscal costs of retirement income. The remainder of this section explains how the population and labour force have been modified for this model.

4.1. Cohort population assumptions

The approach was to extend survival rates[11] provided by Statistics N.Z. out until they reach 0 (implying the cohort has no survivors) and use these to proportionally distribute the population projections category of 90+ for males and females separately. The survival rate provided by Statistics N.Z. were used to derive a survival rate decline for 90-100 year olds, which was then used as a base for extrapolating survival rates for 100+.

The assumption was the decline in survival rates doubles every 10 years following an exponential curve, starting by doubling the 90-100 rate for the 101 year old cohort. This was done for each gender in each period, so decreases in the survival rate decline (or increases in the level at 100) for 90-100 year olds translate into higher survival rates for progressively older cohorts in the period. Using this definition it is obvious that period survival rates for 90+ are monotonically decreasing. However it is not obvious that cohort survival rates are also monotonically decreasing. While it is in theory possible to have cohort survival rates increase if there were a large shift in survival rates across periods, the decreasing trend in survival rates is sufficiently stronger than any period movements to ensure cohort survival rates do not increase. The survival rates are shown in Figures 2 and 3.

Based on the survival rates the 90+ population was proportionally distributed into single year of age groups. The logic is that the survival rates imply a relative probability of survival (so if there were only two age groups, one with a 60% survival rate and one with a 20% survival rate we would expect 75% to be in the first group and 25% to be in the second group). This is ignoring cohort effects, which would alter the relative proportion of survivors within a group. For instance if this method were used to impute the entire population there would be an cohort inconsistency between births (with a lower survival probability) and 1 year olds (with a higher survival probability).

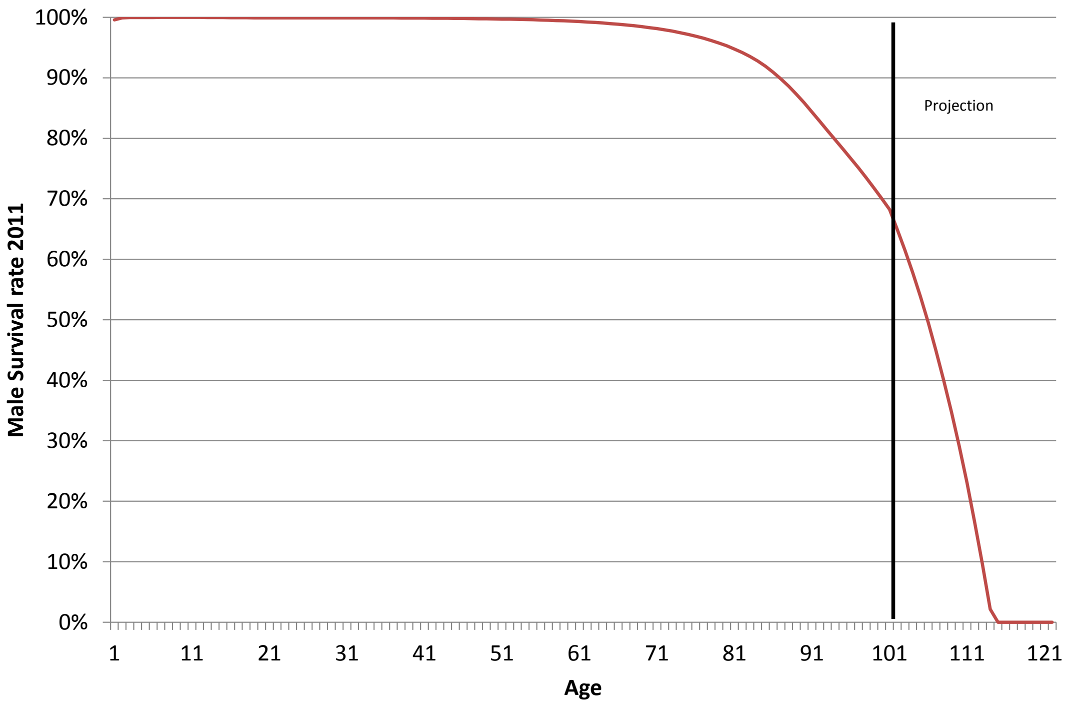
The effect of this allocation to single year of age is not very significant for aggregate-level fiscal costs as there are not generally sharp differences between cohorts over the age of 90. There is no effect on the distributional measures due to single year of age allocation as these use the survival rates. however differing specifications of survival rates can have an effect. The specification of the survival rates affect the average life expectancy, which changes the cost of NZS and the proportion of NZS that an annuity can fund. However, most of the movement in life expectancy is captured by the official population projections, so to the extent that official population projections accurately reflect changes in mortality this is reflected in the model.

[9] `http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/NationalPopulationProjections_HOTP2011.aspx`

[10] `http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/NationalLabourForceProjections_HOTP06-61Augupdate.aspx`

[11] The survival rates for age x is the conditional probability of living to age $x+1$ given you live to age x.

Figure 2. 2010 Cross-section Male Survival Rates



Source: Statistics N.Z., Author calculations

4.2. Labour force participation rates

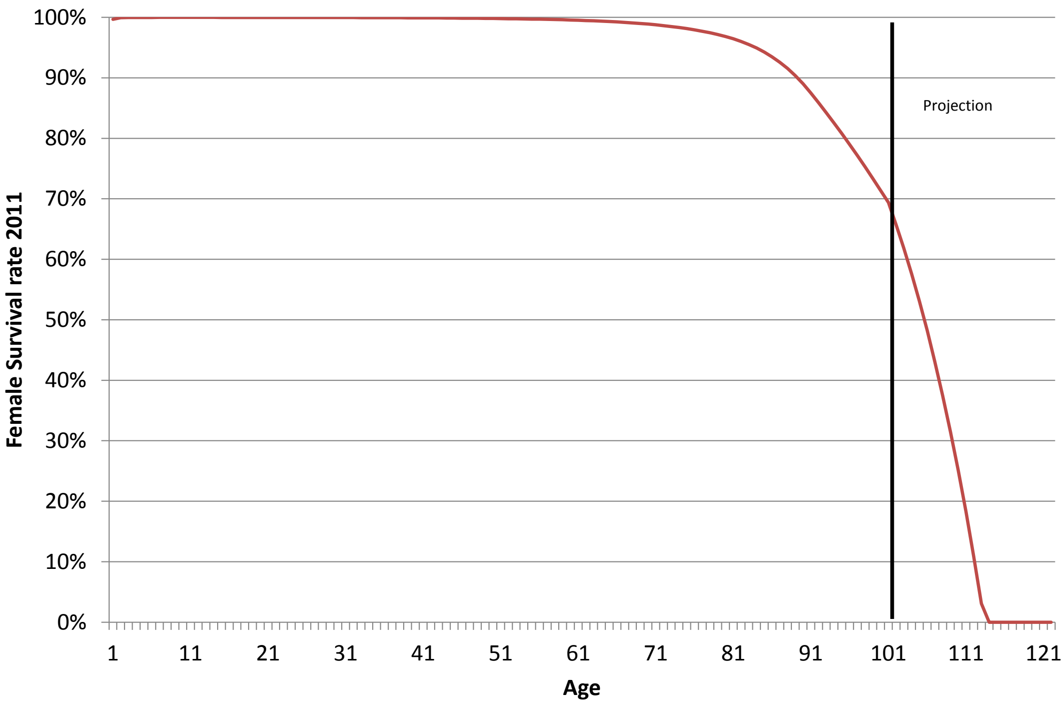
Data on labour force participations rates (LFPR) were provided by Statistics N.Z. by gender, by single year of age between 15 and 79 and by fiscal year from 2005/06 to 2110/11. While LFPR data were provided for the 80+ group those were not incorporated into the model, primarily because the contribution to measures, both distributional and aggregate, is marginal under the current set of policies considered with this model. This is highlighted as an area for improvement that would be required if this model were to be extended to policies involving income-testing NZS entitlements. However even with these policies the behavioural response to the introduction of income testing would be significant for this group.

While there are interactions between labour force participation rates and other variables consider, as is demonstrated in the following sections, all of the effects captured in the model are assumed to flow through income. Initial experiments attempting to modify participation rates proved to be unrealistic or insignificant, which makes this a possible area for improvement.

5. Education

This section considers the effects that education has on retirement income. There are both direct effects through labour force participation rates and indirect effects through income, mortality and couple formation. The discussion about the relationship between education and mortality is left until Section 8, with the remainder of this section devoted to the links between education and other variables in the model such as income and couple

Figure 3. 2010 Cross-section Female Survival Rates



Source: Statistics N.Z., Author calculations

formation. The section concludes with the modelling approach that has been used to include education.

5.1. Differential effects of education

The impacts which education has on an individual are complex, especially when considered in the context of intergenerational inequality. There is an evidence-based link between parental education achievement and child educational achievement both internationally and in New Zealand, see OECD (2012). With the effect of education on assortative mating, the tendency for people with similar educational attributes to form couples, this may serve to reinforce intergenerational inequality.[12] There are offsetting factors to educational assortative mating covered in Chapter 11 of Kalwij & Gustafsson (2006), fertility rates and couple formation rates vary inversely with educational attainment and assortative mating relies on the availability of suitable partners, which may reduce inequality over time.

Intergenerational transmission is very difficult to model explicitly so it is not included. However, there is still significant interaction between education and labour force participation, and education and income. The link between education and income, commonly referred to as an earnings premium, is not as high in New Zealand. Key points from OECD (2012) (modified to include New Zealand values) are:

- People with tertiary (higher) education reap a substantial earnings premium in the labour market. On average across OECD countries, a person with a tertiary degree can expect to earn 55% more than a

[12] See Mare (1991) and the references within for a discussion in the context of the U.S. and Blossfeld & Timm (2003) for a cross country comparison.

person with an upper secondary or post-secondary non-tertiary education. The equivalent number for New Zealand is 18%.[13]

- Similarly, people who lack an upper secondary education face a severe earnings penalty in the labour market. A person without an upper secondary degree can expect to earn 23% less than a person who has completed this level of education, on average across OECD countries. The equivalent number for New Zealand is 21%.

- The earnings premium for tertiary-educated individuals also increases with age. A 25-34 year-old with this level of education can expect to earn 37% more than a similarly-aged person who has completed an upper secondary education, while a 55-64 year-old with a tertiary education can expect to earn 69% more than a similarly-aged counterpart with an upper secondary education. The equivalent numbers for New Zealand are 12% and 29%.

The second differential effects considered in this section are labour market outcomes such as participation and unemployment. Key points from OECD (2012) (modified to include New Zealand values) are:

- Across OECD countries, individuals with at least an upper secondary education have a greater chance of being employed than people without an upper secondary education. On average, employment rates are 18 percentage points higher for those with an upper secondary education and 28 percentage points higher for those with a tertiary education, compared to individuals who have not completed an upper secondary education.

- The probability of working full time generally increases with higher levels of education for both men and women, but most full-time earners are men. The proportion of individuals working full time is 10 percentage points higher among those with a tertiary education than among those without an upper secondary education.

The differential effects of education on labour force can be demonstrated by using New Zealand Census data in Table 1. It is clear both labour force participation and unemployment are correlated with educational attainment. The differential effects of education on income in New Zealand can also be analysed from Census data, presented in Table 2.

The causal link between education and labour market outcomes seems to be mutually reinforcing, as valid arguments can be made to establish causal links in both directions. For example a demand for skills increases the earnings premium from education establishes a causal link from income to education, compared to the level of education reflects the level of human capital accumulation, hence the productivity and general employability of the person establishing a causal link from education to income. This is conceptually difficult to incorporate into a modelling framework, so the next section outline the modelling approach we have chosen, namely to use education as the exogenous variable to determine income.

[13] See Maani & Maloney (2004), among others, for a more detailed analysis of the earnings premium in New Zealand.

[14] All figures are for the census usually resident population aged 15 years and over.

[15] In 2006 data for highest qualification is output in two ways. This table shows categories that are consistent with the new qualifications framework. The other way is with categories that distinguish between qualifications gained at school and post-school. For further information on the qualifications framework, refer to the Statistical Standard for Qualifications, available from Statistics New Zealand's website.

[16] `http://www.stats.govt.nz/Census/2006CensusHomePage/QuickStats/quickstats-about-a-subject/education-and-training.aspx`

Table 1. Labour force type (%) by qualification

Highest qualification[15]	Labour force status[14] Employed full time	Employed part time	Unemployed	Not in the labour force
No qualification	37.6	12.4	4.1	45.8
Level 1 certificate	49.7	18.1	3.8	28.4
Level 2 certificate	53.3	19.3	3.7	23.8
Level 3 certificate	47.7	20.2	5.4	26.7
Level 4 certificate	66.7	11.3	2.1	19.9
Level 5 diploma	65.1	14.4	2.8	17.6
Level 6 diploma	53.2	18.6	1.7	26.5
Bachelor degree and level 7 qualification	67.3	14.2	2.6	15.9
Post-graduate and honours degrees	70.1	14.2	2.0	13.7
Masters degree	69.4	12.4	2.5	15.7
Doctorate degree	74.9	9.5	1.3	14.3
Average	48.4	14.4	3.4	30.4

Source: Statistics NZ[16], Author calculations

5.2. Modelling approach for differential education outcomes

Simplifying assumptions need to be made to make the modelling tractable. Years of formal education[17] are considered the proxy for individual education (which may include other forms of education such as in-work training, professional associations, etc.). Education is considered the anchor variable in the model, so education is first determined and used to inform our modelling of other variables such as couple formation, income and mortality rates.

First a review of the New Zealand data on transitions between educational attainment. Educational attainment does not generally decrease over time, although the returns of educational attainment may decrease over time as average educational attainment increases. As seen in Figure 4 based on the 2006 Census most of the full-time study occurs before the age of 30, which informs our modelling approach.

All educational attainment occurs before the age of 65, with most educational attainment occurring before the age of 35. An exponential curve was fitted to the age 15-34 data points[18] separately for males and females to derive the aggregate participation rate. Finally some modification needed to made for education continuity, or the tendency for people who are in formal study to be more likley to remain in formal study. This was done by increasing the conditional probability for people who were in formal study the previous year[19] and offsetting the conditional probabilities for people not in study to maintain the same aggregate participation rate on average. The final transition probabilities by gender and selected ages are included in Table 5.

The final component of the education module is how to treat cohorts which may have already educational

[17]This is imputed from the length of full time study that would ordinarily be required for a particular formal qualification.

[18]This is to model more accurately the participation of the people more likely to be participating in formal study. Based on the limited data publicly available from Census there seems to be a fundamental shift from an exponential decay in the 15-34 age group and a much slower Gompertz decay from the age of 35. This is similar to the "*Gomp ex*" model sometimes used to model the growth of tumours, the interpretation being that there is initially no competition for resources so growth can occur exponentially, and at some critical value after which the process follows a Gompertz law (Wheldon 1988).

[19]If $\kappa = \alpha \exp(-\beta x)$ is the aggregate participation rate for formal study, then the conditional participation rate for people in study the previous year is modified to $\kappa' = \alpha \exp(-\frac{\beta x}{2})$. This is an assumption that is based on the author's judgement in the absence of compatible data.

Table 2. Income category (%) by qualification

	Male					Female				
	<$20,000	$20,001–$40,000	$40,001–$70,000	$70,001–$100,000	$100,001 or more	<$20,000	$20,001–$40,000	$40,001–$70,000	$70,001–$100,000	$100,001 or more
No qualification	43	31	15	2	2	62	23	4	1	0
Level 1 certificate	34	32	22	4	3	49	31	11	1	1
Level 2 certificate	32	30	23	6	5	47	31	14	2	1
Level 3 certificate	42	27	19	5	4	56	28	10	1	1
Level 4 certificate	21	30	35	7	4	42	37	15	2	1
Level 5 diploma	20	26	33	11	8	38	35	19	3	2
Level 6 diploma	19	24	34	13	9	36	32	25	3	2
Bachelor degree or level 7 qualification	18	21	29	14	18	30	28	30	6	4
Post-graduate and honours degrees	14	17	30	17	21	25	24	35	10	6
Masters degree	15	17	29	17	21	26	22	33	11	7
Doctorate degree	8	11	25	24	31	14	14	33	21	16

Source: Statistics NZ, Author calculations

Table 3. Highest qualification (%) by age group, Males, Census 2006

	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	80–84	85 and over
No qualification	34	17	17	16	20	21	22	24	30	35	38	40	41	39	40
Level 1 certificate	26	13	11	11	12	12	11	12	11	10	9	9	9	10	11
Level 2 certificate	20	12	11	11	10	10	9	9	6	6	5	6	6	9	10
Level 3 certificate	15	24	12	10	6	5	5	5	5	4	4	3	4	5	5
Level 4 certificate	2	9	13	16	18	18	19	17	17	17	18	17	16	15	12
Level 5 diploma	1	4	4	4	5	5	6	6	5	5	4	3	3	2	2
Level 6 diploma	0	3	3	4	4	4	5	5	5	4	4	4	4	4	3
Bachelor degree and level 7 qualification	0	11	18	16	14	12	12	11	9	8	7	6	6	7	7
Post-graduate and honours degrees	0	1	3	3	3	2	2	2	2	1	1	1	1	1	1
Masters degree	0	0	2	3	3	3	3	3	3	2	2	1	1	1	2
Doctorate degree	0	0	0	1	1	1	1	1	1	2	1	1	1	1	1
Overseas secondary school qualification	3	6	5	5	6	6	5	5	5	6	8	8	8	6	6

Source: Statistics NZ, Author calculations. Note that non-respondents and unidentifiable responses have been removed for calculation of percentages.

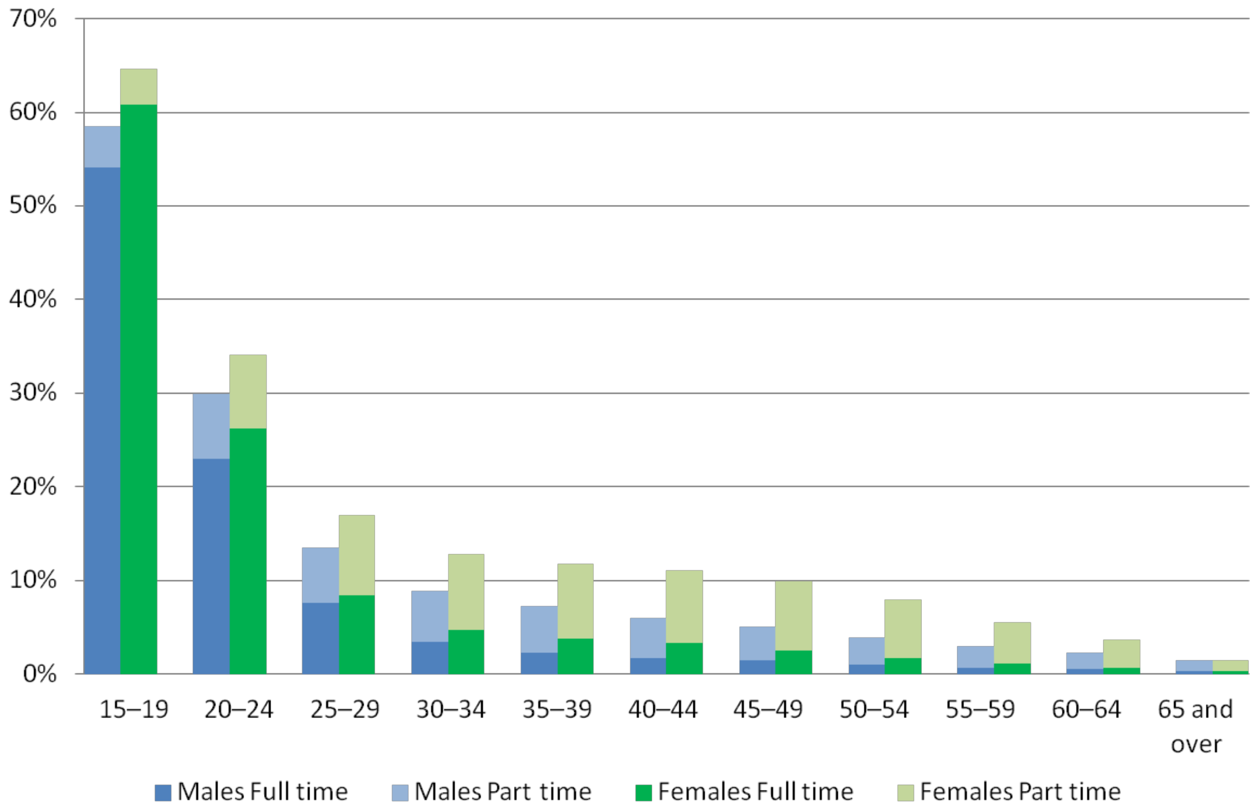
Table 4. Highest qualification (%) by age group, Females, Census 2006

	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	80–84	85 and over
No qualification	28	12	12	12	16	17	20	25	35	41	44	48	50	49	55
Level 1 certificate	26	10	10	11	16	16	17	18	16	15	14	12	11	13	12
Level 2 certificate	22	12	11	14	14	14	12	9	6	5	5	5	6	8	8
Level 3 certificate	19	27	14	10	6	6	5	4	4	3	3	3	4	5	5
Level 4 certificate	2	6	6	7	7	8	8	7	6	5	4	3	3	3	3
Level 5 diploma	1	6	6	5	4	4	4	3	3	2	2	2	1	1	1
Level 6 diploma	0	3	4	6	7	8	10	11	11	12	12	12	10	9	7
Bachelor degree and level 7 qualification	0	17	24	21	16	14	13	11	8	6	5	4	3	3	2
Post-graduate and honours degrees	0	2	4	4	3	3	3	2	2	1	1	0	0	0	0
Masters degree	0	1	3	3	3	3	3	3	2	1	1	1	1	1	0
Doctorate degree	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
Overseas secondary school qualification	2	6	6	6	7	7	7	7	7	8	9	10	9	9	7

Source: Statistics NZ, Author calculations. Note that non-respondents and unidentifiable responses have been removed for calculation of percentages.

achievements. Census data is presented in Table 3 for Males and Table 4 for Females. This is used to inform the starting level of years of formal education.

Figure 4. Age Group and Gender by Study Participation, N.Z. Census 2006



Source: Statistics N.Z., Author calculations

6. Couple formation

To get an accurate projection of distributional measures for retirement, couple formation needs to be considered. With males on average earning more than females over the life cycle, any change from a defined benefit scheme like NZS to an defined contribution scheme, such as a compulsory version of KiwiSaver, would show a larger distributional impact on women. Couple formation is a redistributive mechanism between males and females that needs to be considered to model the redistributive impact of the policy changes that have been modelled. It is also true that a switch from defined benefit to defined contribution will have progressivity impacts through differential mortality. This is considered further in section 8.

Without making any inferences about why such income differentials exist,[20] it is widely accepted that on average there are income and labour force participation rate differentials between males and females. This can be demonstrated in New Zealand through Census data (which has implicitly been presented in the Labour Force projections and Table 2) and through estimates based on the Household Economic Survey, as presented in Ball & Creedy (2012) which this model is heavily dependent on.

[20] For instance, see Becker (1991).

Table 5. Conditional transition probabilities of study status by gender and age from 16–34

Age	Male conditional on previous year study	Male conditional on previous year not studying	Female conditional on previous year study	Female conditional on previous year not studying
16	72%	55%	76%	56%
17	65%	45%	69%	48%
18	59%	39%	63%	41%
19	54%	34%	58%	36%
20	48%	29%	53%	32%
21	44%	25%	48%	28%
22	40%	22%	44%	25%
23	36%	19%	40%	22%
24	32%	17%	37%	20%
25	29%	15%	34%	17%
26	26%	13%	31%	15%
27	24%	11%	28%	14%
28	22%	10%	26%	12%
29	20%	8%	23%	11%
30	18%	7%	21%	9%
31	16%	6%	20%	8%
32	14%	5%	18%	7%
33	13%	5%	16%	6%
34	12%	4%	15%	6%

Source: Statistics NZ, Author calculations

6.1. Marriage

Marriage[21] is considered the formal channel of redistribution between males and females for policies involving abatement of NZS based on private savings. Under current legislation[22] KiwiSaver and any other future version that retains similar characteristics of private ownership is considered a relationship asset, so in the event of divorce a reasonable first approximation would be that it is split equally. Simlarly if one partner in a marriage dies, the survivor would have the ability to claim at least half of the private savings balance or any benefit derived from decumulation through products such as an annuity.

At this point it is useful to review marriage statistics in New Zealand. The trend has been for declining marriage rates since 1972 (Figure 5) and in the last decade declining divorce rates (Figure 6). As noted in the media release[23] in 2011:

> Just over one-third (35 percent) of couples who married in 1986 had divorced before their silver wedding anniversary (25 years).

[21] Marriage is used here as it is defined by Statistics New Zealand as quoted below from `http://www2.stats.govt.nz/domino/external/omni/omni.nsf/outputs/marriages`

> The act, ceremony or process by which the legal relationship of husband and wife is constituted.

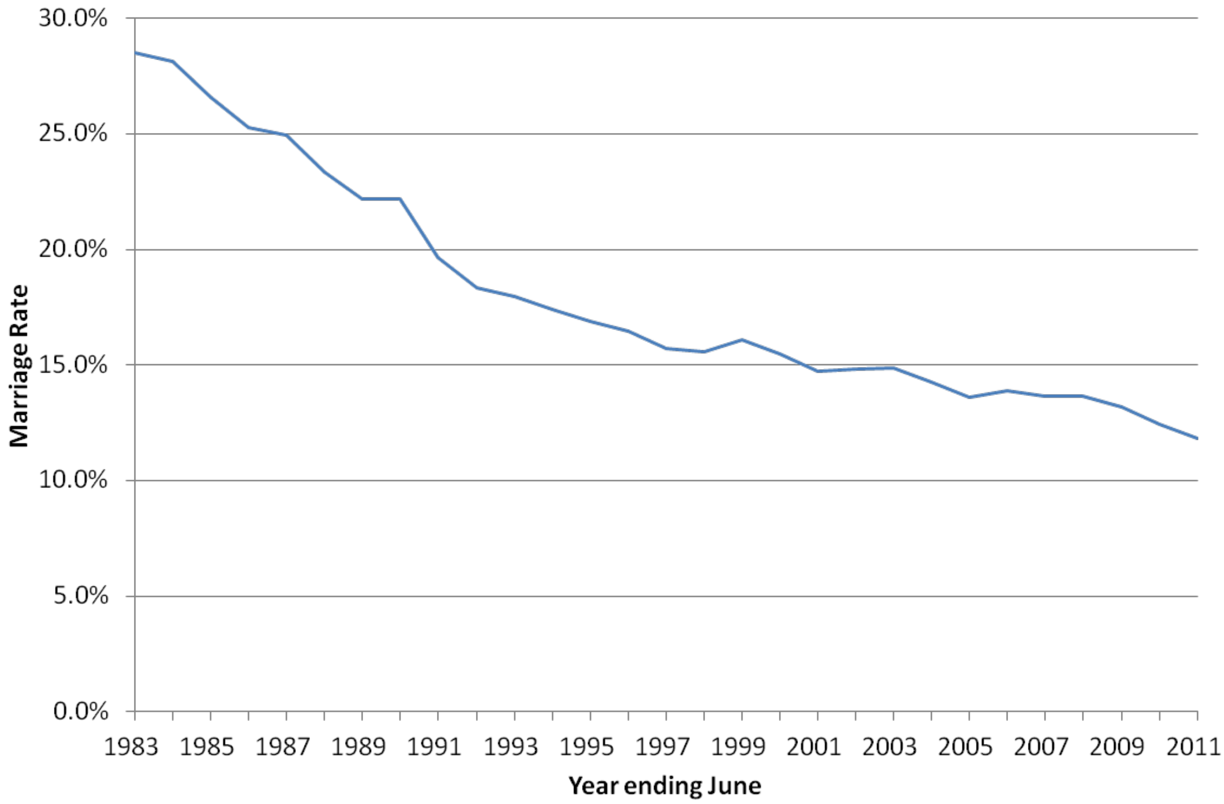
This definition excludes civil unions which as at year end June 2011 were less than 2% of the number of marriages. Civil unions were also excluded from the modelling.

[22] Property Relationships Act 1976, `http://www.legislation.govt.nz/act/public/1976/0166/latest/DLM440945.html`.

[23] `http://www.stats.govt.nz/~/media/Statistics/Browse%20for%20stats/MarriagesCivilUnionsandDivorces/HOTPYeDec11/MarriagesCivilUnionsandDivorcesYeDec11HOTP.pdf`

and looking at particular marriage cohorts (based on year of registration) a similar pattern can be seen.

Figure 5. Marriage rates 1972-2011



Source: Statistics New Zealand

Current marriage stocks can be estimated from 2006 Census[24] and are summarised in Table 6. Also included are the changes since Census 1996 in Table 7. This allows us to decompose the decreasing marriage rate into trends by age cohort, so that the trend in marriage rates is not being driven by a shifting demographic profile that has been induced by the post war baby boom.

As can be seen from the Census data, marriage rates have been declining over the 10 years 1996 to 2006 for all cohorts except for females over 65 and males over 85. This has generally been offset by an increase in the “Other partnership” category, showing a preference shift to de-facto relationships.

The assumption moving into the projection period is that we are projecting the combined total of marriage and other partnership. These categories would both be highly likely to have KiwiSaver and other private savings considered as relationship property. No change in the aggregate rate by cohort is projected, and the other advantage of this approach is that it does not require and assumption about the relative prevalence of marriage and de-facto relationships.

6.2. Modelling couple formation

One of the common themes in modelling is that you want to incorporate as much of the relevant phenomena while simultaneously keeping the model as simple as possible. In this area in particular the assumptions made are questionable. However in the context of the model they cover the important redistributive role which couple formation has between males and females. The basic modelling framework for couple formation is presented below, with ‘married’ meaning in a couple recognised for the purposes of relationship property.

[24] Through TableBuilder on the Statistics New Zealand website

Table 6. Social marital status (%), 5 year age band and gender, 2006

	Male				Female			
Age	Marriage Rate	Other partnership	Divorced not currently partnered	Bereaved not currently partnered	Marriage Rate	Other partnership	Divorced not currently partnered	Bereaved not currently partnered
15-19 Years	0.1%	1.8%	0.02%	0.02%	0.2%	3.5%	0.02%	0.02%
20-24 Years	1.9%	9.9%	0.06%	0.02%	3.8%	12.6%	0.09%	0.02%
25-29 Years	10.4%	13.8%	0.28%	0.02%	14.4%	13.6%	0.43%	0.05%
30-34 Years	21.0%	11.5%	0.68%	0.04%	23.6%	10.1%	1.12%	0.10%
35-39 Years	26.5%	8.9%	1.32%	0.07%	27.4%	7.8%	2.13%	0.21%
40-44 Years	29.2%	7.3%	2.07%	0.12%	29.0%	6.4%	3.37%	0.41%
45-49 Years	31.0%	6.0%	2.84%	0.23%	30.0%	5.5%	4.28%	0.77%
50-54 Years	32.6%	5.1%	3.37%	0.38%	31.0%	4.5%	5.07%	1.45%
55-59 Years	34.2%	4.3%	3.61%	0.65%	31.9%	3.3%	5.43%	2.60%
60-64 Years	35.6%	3.2%	3.43%	1.19%	31.6%	2.1%	5.20%	4.96%
65-69 Years	36.2%	2.2%	3.20%	2.08%	29.9%	1.4%	4.39%	8.65%
70-74 Years	35.7%	1.6%	2.85%	3.76%	25.6%	0.8%	3.53%	14.17%
75-79 Years	33.9%	1.2%	2.14%	6.17%	19.7%	0.6%	2.52%	20.63%
80-84 Years	30.2%	0.9%	1.53%	9.78%	12.6%	0.4%	1.76%	27.45%
85 Years +	22.4%	0.8%	0.87%	15.86%	5.0%	0.4%	0.99%	32.40%

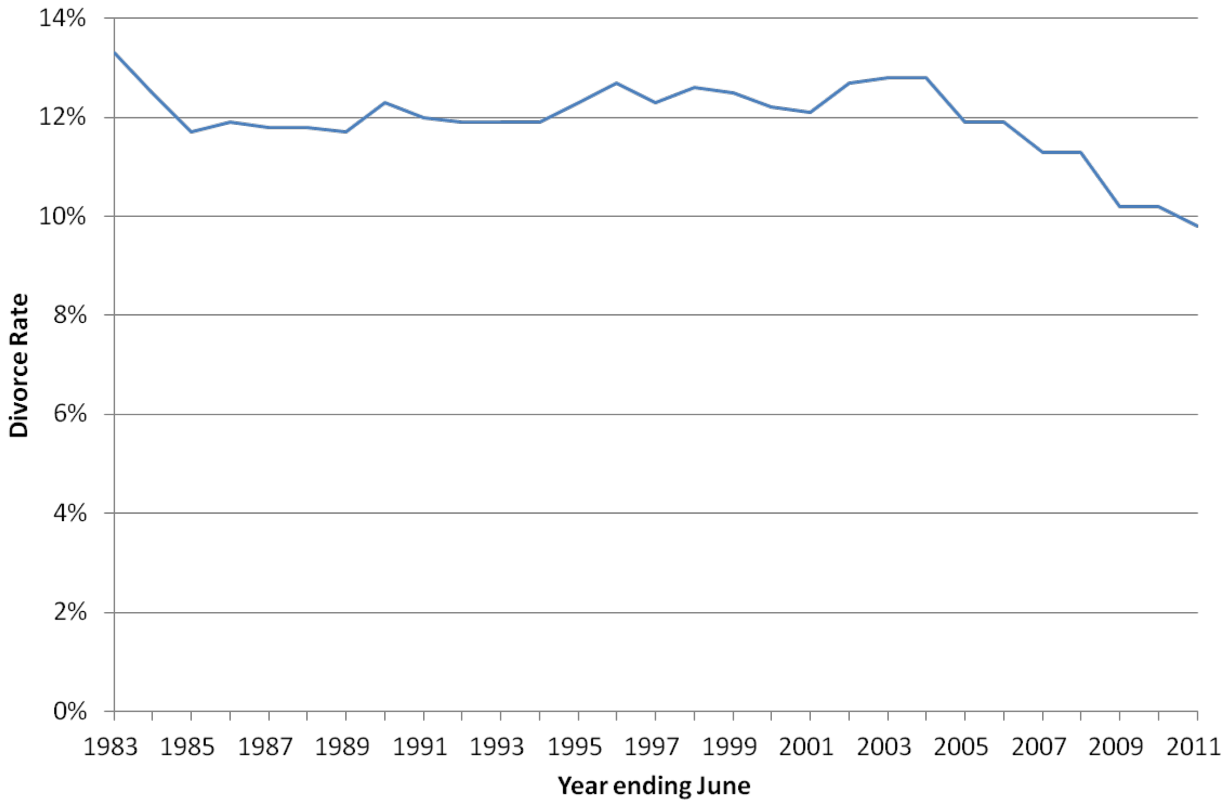
Source: Statistics New Zealand, Author calculations

Table 7. Changes in social marital status (%), by 5 year age band and gender, between 1996 and 2006

Age	Male				Female			
	Marriage Rate	Other partnership	Divorced not currently partnered	Bereaved not currently partnered	Marriage Rate	Other partnership	Divorced not currently partnered	Bereaved not currently partnered
15-19 Years	0.0%	0.6%	0.0%	0.0%	-0.1%	0.7%	0.0%	0.0%
20-24 Years	-1.0%	2.2%	0.0%	0.0%	-2.4%	2.4%	0.0%	0.0%
25-29 Years	-4.1%	3.5%	-0.1%	0.0%	-5.8%	4.0%	-0.2%	0.0%
30-34 Years	-5.0%	3.9%	-0.4%	0.0%	-5.4%	3.6%	-0.6%	-0.1%
35-39 Years	-5.3%	3.3%	-0.5%	0.0%	-5.2%	3.1%	-0.6%	-0.1%
40-44 Years	-5.7%	2.9%	-0.3%	-0.1%	-5.4%	2.5%	-0.3%	-0.2%
45-49 Years	-5.3%	2.3%	-0.1%	-0.1%	-5.3%	2.2%	0.0%	-0.3%
50-54 Years	-4.7%	2.1%	0.4%	-0.1%	-4.6%	2.1%	0.7%	-0.8%
55-59 Years	-3.9%	2.1%	0.7%	-0.3%	-3.5%	1.9%	1.4%	-1.6%
60-64 Years	-2.6%	1.8%	0.6%	-0.6%	-2.0%	1.3%	1.7%	-2.4%
65-69 Years	-1.5%	1.2%	0.7%	-0.9%	0.1%	0.8%	1.6%	-3.5%
70-74 Years	-1.2%	0.9%	0.9%	-1.2%	1.2%	0.5%	1.4%	-3.9%
75-79 Years	-0.8%	0.7%	0.7%	-1.8%	2.2%	0.3%	1.1%	-4.4%
80-84 Years	-0.1%	0.5%	0.4%	-2.4%	2.0%	0.3%	0.6%	-4.1%
85 Years +	0.6%	0.5%	-0.1%	-4.7%	0.6%	0.3%	0.2%	-5.0%

Source: Statistics New Zealand, Author calculations

Figure 6. Divorce rates 1972-2011

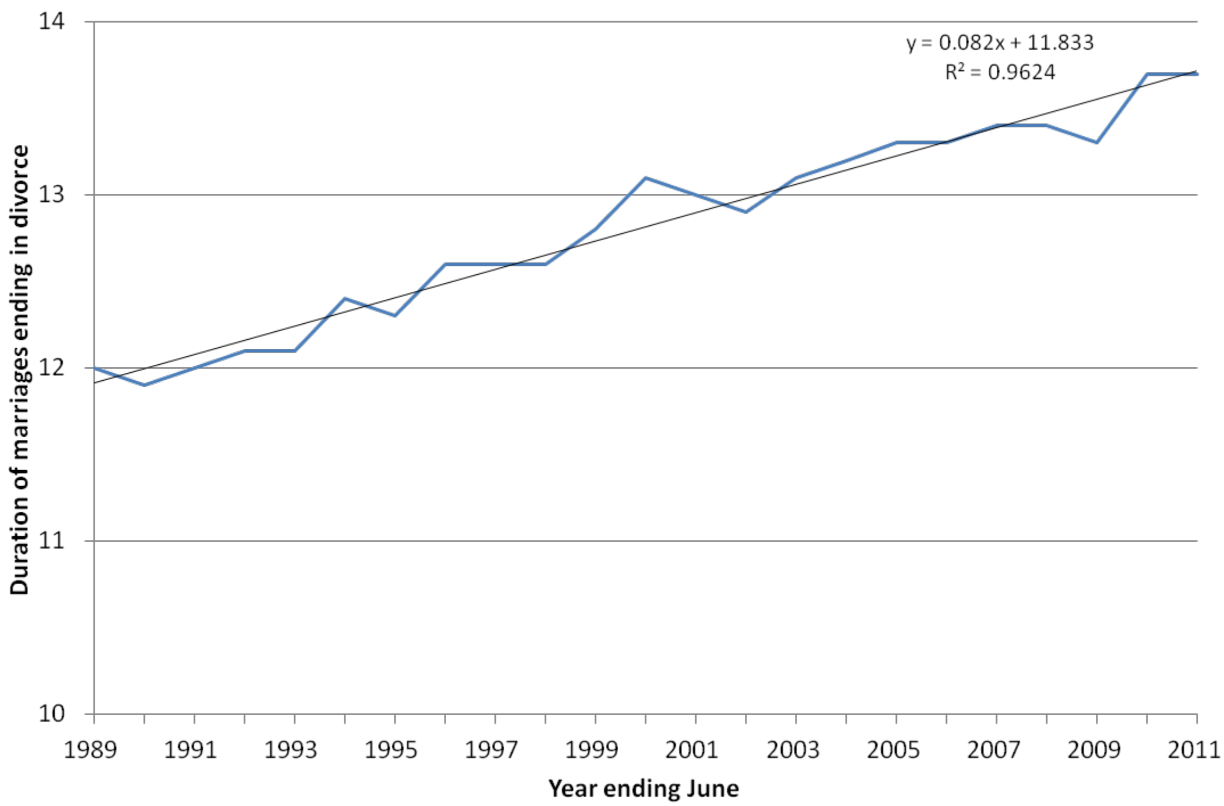


Source: Statistics New Zealand

1. Enter the system. If cohort is aged 15+ in 2010/11, then a marriage variable is imputed using Table 6, go to step 2. If you are over 65 go to step 5. Otherwise you are single when you enter the system, go to step 2.
2. In each year you are either single or married.
   (a) If single go to step 3.
   (b) If married go to step 4.
3. Each year a single person makes a decision to marry or not. If they get married change indicator variable to married and impute a profile for the person they have married. Go to step 5.
4. Each year if you are married three things can happen.
   (a) You stay married, in which case go to step 5.
   (b) You become single through separation, in which case change indicator variable to single, record cause of marriage dissolution and go to step 5.
   (c) You become single through bereavement, in which case change indicator variable to single, record cause of marriage dissolution and go to step 5.
5. At this stage the simulation advances to the next year.
   (a) If you are 65+ marriage variable remains the same from now on.
   (b) If you are under 65 go to step 2.

The two remaining pieces of information are how separation is dealt with and how the age of the partner is selected. An assumption is made about the split of couples which will separate (40%) and when the couple is formed a variable is generated which has value 1 with probability 0.4 and value 0 with probability 0.6.[25] If separation occurs, then the duration of the relationship is generated from a Poisson random variable with mean of 15 years increasing at a rate of 0.08 per year from 2010/11. This reflects the trend over the last 20 years for the median duration of marriage ending in divorce, shown in Figure 7.

Figure 7. Median duration of marriages ending in divorce (years)



Source: Statistics New Zealand, Author calculations

The final step is to calculate the age difference between couples. This was estimated from the pooled HES data, first for the aggregate population, shown in Figure 8 for couples with an age difference between the female being 20 years younger to the female being 10 years older.[26] This was refined to deal with the funneling effect that is seen in couple formation, namely that in general as people age the spread of the age difference between partners in the couple increases. The final distributions of age difference based on pooled HES data are presented in Table 8, modelled based on HES data. The distribution of the age difference is assumed to be Binomial with a gender specific offset and age/gender specific p parameter.

Let $X_{i,j}$ be a Binomial random variable for age cohort i ($i = 1$ represents 15-19, $i = 2$ represents 20-24, etc. until 65+) and gender j (0 for males and 1 for females). Let $N_{i,j} = 30$ be the number of trials associated with the Binomial distributions, and let $p_{i,j}$ be the values represented in Table 8. Then the final age difference Y defined in terms of a Binomial random variable X:[27]

$$\mathbb{P}\left\{X_{i,j} = x\right\} = \frac{30!}{(30-x)!x!} p_{i,j}^{x}(1-p_{i,j})^{30-x} \qquad x = 0, 1, \ldots, 30 \tag{1}$$

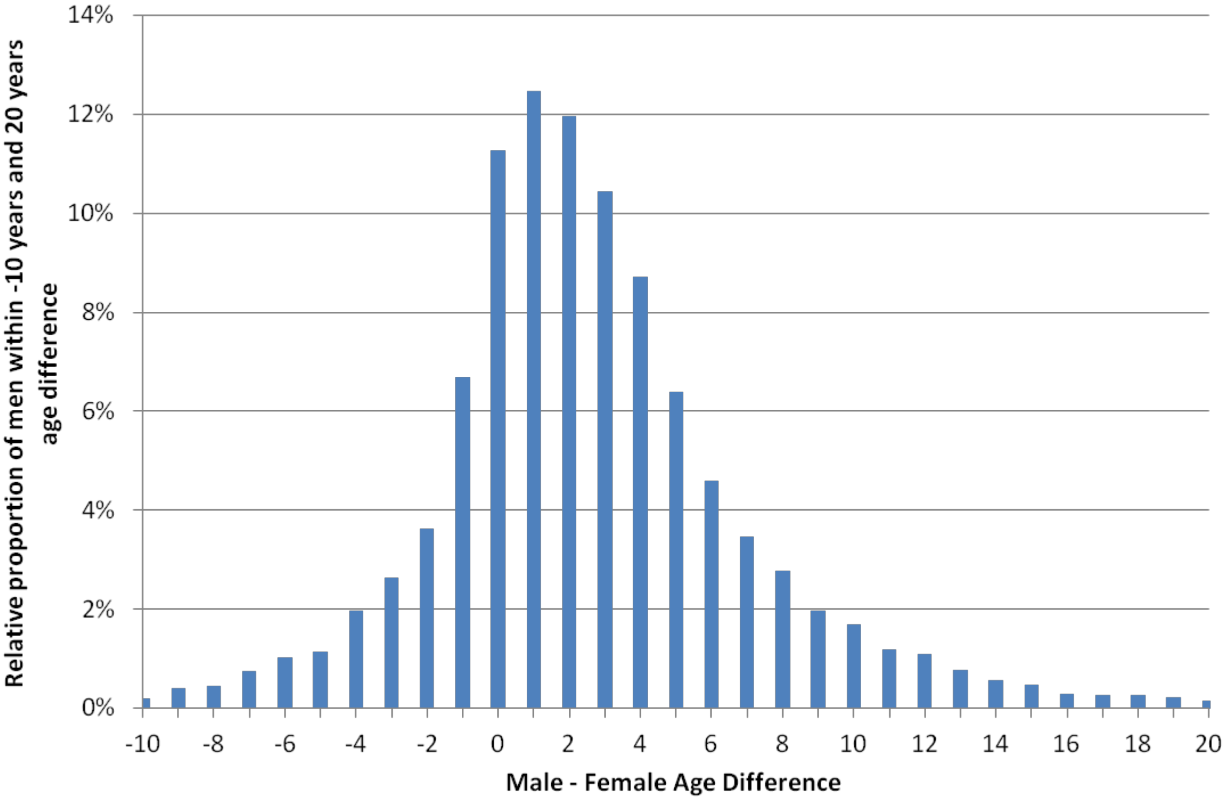
$$Y_{i,j} = X_{i,j} - 10j - 20(1-j) \tag{2}$$

[25] This is known as a Bernoulli variable.

[26] This accounts for more than 98% of couples in the pooled HES data.

[27] Modified to ensure that the partner remains above the age of 15.

Figure 8. Age difference in years relative to the male



Source: Statistics New Zealand, Author calculations

Table 8. Cohort specific age differences distributional parameters for couple formation

	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
Male p	0.32	0.34	0.36	0.37	0.4	0.41	0.43	0.43	0.44	0.45	0.46
Female p	0.55	0.57	0.56	0.57	0.58	0.59	0.59	0.58	0.58	0.58	0.59

Source: Household Economic Survey, Author calculations

7. Income

One of the innovations of this model is the inclusion of income profiles, which allow the calculation of the effects of defined contribution policy options. The framework we use to project individual income is built up from two parts, the static profiles estimated from pooled cross-sectional data and the dynamics that govern how an individual shifts within the income distribution relative to the remainder of the cohort. The lognormal distribution was chosen for this purpose, with a functional form applied to the distributional parameters, following established frameworks for projecting income for age-based cohorts, for example, in Ball & Creedy (2012) and Creedy (1997).

This section covers how the income distribution is constructed for the base year 2010/11, and how the individuals which form the core of the model were dynamically projected. This is a mechanism that allows for individuals to have realistic income profiles and income mobility over the lifetime, which is important for constructing reliable projections of the distributional measures.

7.1. Static income profiles

The work in this section is based heavily on Ball & Creedy (2012). Using the Household Economic Survey a regression was fitted to find an age-related parametrisation of lognormal distributional parameters for the New Zealand population in the base year 2010/11.

Let X be the distribution of possible incomes for an individual in the base year 2010/11. There are two key assumptions that we used to derive our income profiles. The first assumption is that the distribution of income for an age cohort is lognormally distributed, with cumulative distribution function

$$\mathbb{P}\{X \leq x\} = \int_{-\infty}^{x} \frac{1}{x\sqrt{2\pi\sigma^2}} \exp\left(-\frac{(\ln x - \mu)^2}{2\sigma^2}\right) dx \tag{3}$$

It can be shown that if Z is a normally distributed variable with mean 0 and standard deviation 1 then

$$X = \exp(\mu + \sigma Z) \tag{4}$$

which will be a key property when the income dynamics are considered.

The second assumption is that the parameters of an individuals lognormal distribution, namely μ and σ, are related by the following functional forms. For males the functional form is

$$\mu_i = \alpha_0 + \alpha_1 i + \alpha_2 i^2 + \zeta_1 K + \zeta_2 M \tag{5}$$

$$\sigma_i^2 = \gamma_0 + \gamma_1 i \tag{6}$$

and for females the functional form is

$$\mu_i = \alpha_0 + \alpha_1 i + \alpha_2 i^2 + \alpha_3 i^3 + \zeta_1 K + \zeta_2 M \tag{7}$$

$$\sigma_i^2 = \gamma_0 + \gamma_1 i. \tag{8}$$

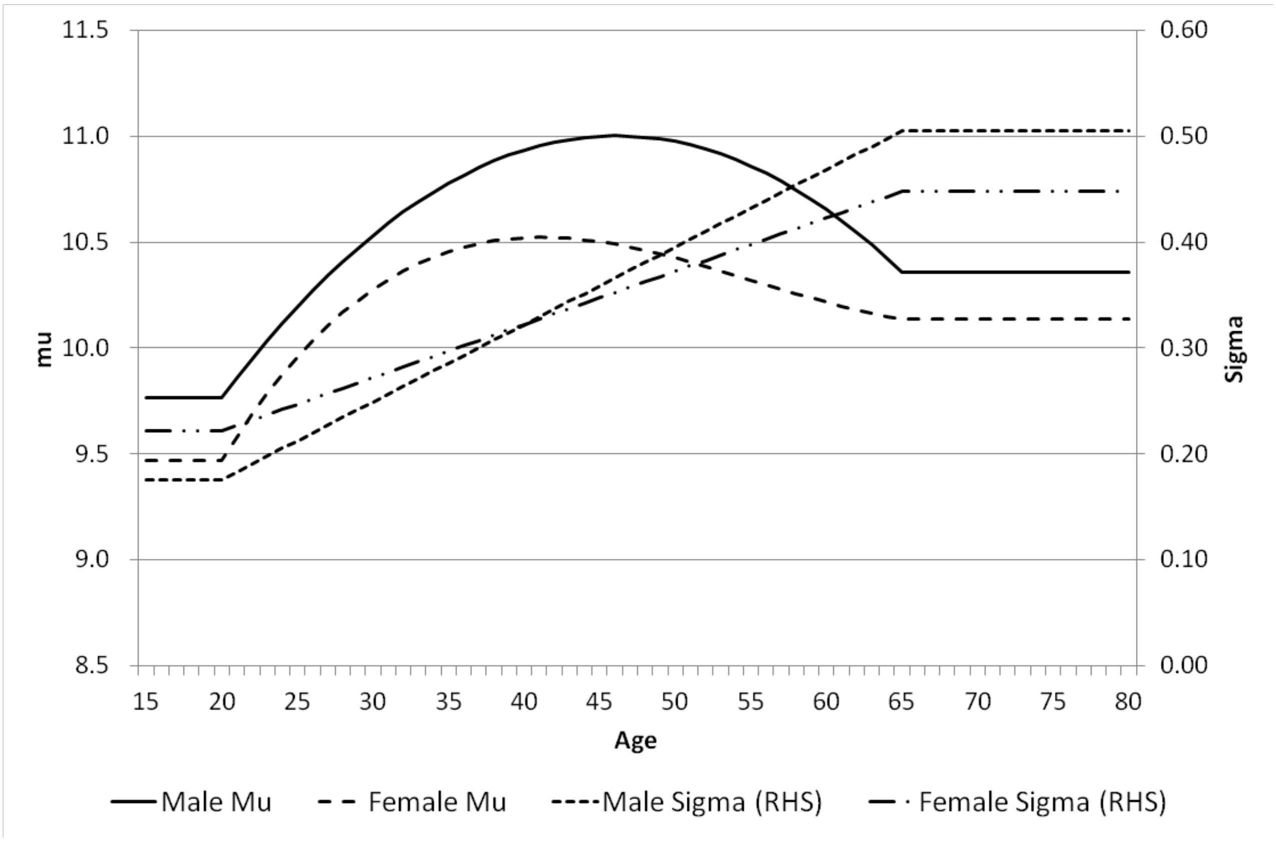
In this specification i is the age of the individual, K is a proxy for years of formal education, M is an indicator variable for in a couple, μ_i is the mean of the normal distribution associated with the lognormal distribution for age i, σ_i is the standard deviation of the normal distribution associated with the lognormal distribution for age i and $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \gamma_0$, γ_1, ζ_1 and ζ_2 are regression parameters. Note that male and female parameters were estimated separately.

The above model is slightly different than that estimated in Ball & Creedy (2012), however it is estimated using the same data set augmented with an education and couple status variables. The static distributional parameters for the regression parameters are in Table 9, with the associated distributional parameters for each age shown in Figure 9. Ball & Creedy (2012) include a more detailed discussion about the data preparation and how the regressions were performed.

Table 9. Regression parameters for income statics

Parameter	Male	Female
α_0	9.146	8.788
α_1	0.0817	0.0917
α_2	-1.306×10^{-3}	-2.014×10^{-3}
α_3	–	-1.084×10^{-5}
ζ_1	0.0823	0.1034
ζ_2	0.3042	0.1478
R^2 for 5 and 7 respectively	0.7906	0.6985
γ_0	0.1393	0.2118
γ_1	7.318×10^{-3}	3.362×10^{-3}
R^2 for 6 and 8 respectively	0.6456	0.2235

Figure 9. Distributional parameters for static income



Source: Ball & Creedy (2012), Author calculations

7.2. Income dynamics

The theoretical foundations for this section are based on Carey, Creedy, Gemmell & Teng (2012), which is heavily influenced by the earlier papers of Creedy (1997, 1982). Given the base year income for a cohort, denoted $y_{i,0}$, we now need a way to project forward the income. Some key observations from income data are that there is a noticeable trend of mean reversion, or regression toward the mean, and that income is autoregressive, in this context assumed to be an AR(1) process where an individual's income in period t is correlated with their income in period $t+1$.

Let $u_{i,0}$ be a draw from $N(0,1)$ (standard normal distribution) then the base income can be derived using 4, $M_{i,0} = \mu_i$ and σ_i as

$$y_i = \exp\left(M_{i,0} + \sigma_i u_{i,0}\right)$$

Consider projecting this base income out to time t: $t = 1,2,3,\ldots,80-i$. As a cohort ages they will experience both economy wide wage growth[28] and age-related productivity growth which will affect the cohorts' distributional growth. This is incorporated by modifying the M_{i+t} term to

$$M_{i+t} = \mu_{i+t} + \beta t \tag{9}$$

where β is the natural logarithm of the economy wage growth. Next we include the autoregressive term in the variance term $u_{i,t}$ as

$$u_{i,t} = \eta u_{i,t-1} + \varepsilon_{i,t} \tag{10}$$

where η is the autoregressive term and $\varepsilon_{i,t}$ is an independent draw from the normal distribution $N(0,\sigma^2_{i+t})$.[29] Finally we tie this all together to produce a draw for income for the next period.

$$y_{i,t} = \left(\frac{y_{i,t-1}}{m_{i,t-1}}\right)^{\xi} \exp(M_{i,t} + u_{i,t}) \tag{11}$$

where $m_{i,t-1}$ is the cohort's geometric mean income from period $t-1$ and ξ is the parameter which determines the degree of mean reversion, with $\xi = 0$ implying a Markov process, $0 < \xi < 1$ implying mean reversion and $\xi > 1$ implying divergence from the mean.

The final missing part before we can project incomes is the parameters η and ξ. In Creedy (1997) the autoregressive parameter varied between cohorts, with a similar functional form and shape to the income static profiles for μ_i. With the updated work by Carey et al. (2012) this parameter was assumed to be constant. The final values used in the model were $\eta = -0.233$ and $\xi = 0.891$.

8. Differential mortality

This theoretical modelling framework for differential mortality is based heavily on earlier work by Creedy (1982). A more comprehensive review of differential mortality can be found in Feinstein (1993). The following sections consider the empirical evidence and literature underpinning differential mortality, and our modelling of this for retirement income.

[28] Following the Long Term Fiscal Model (LTFM) wage growth is assumed to be 3.53% p.a. The LTFM is available at `http://www.treasury.govt.nz/government/longterm/fiscalmodel` with a technical modelling companion Rodway & Wilson (2006).

[29] We have assumed that we want to project one period at a time. If we wanted to project more than one period ahead we can use the properties of the normal distribution to get

$$u_{i,t} = \eta^t u_{i,0} + \varepsilon'_{i,t}$$

where $\varepsilon'_{i,t}$ is a draw from the normal distribution $N\left(0, \sum_{k=0}^{t} \eta^k \sigma^2_{i+k}\right)$.

The pioneering work in differential mortality was Kitagawa & Hauser (1973), which illustrated the relationship between education and mortality rates for population subgroups based on age, sex and race shown in Table 10. Kitagawa & Hauser (1973) also estimate the relationship between income and mortality, shown in Table 11, however they state

> In our judgement, the education differentials probably provide more reliable indicators of socioeconomic differentials in mortality in the United States in 1960 than do the income differentials.

The key concept is that mortality rates have a strong correlation with lifetime resources, with the more commonly used proxies for lifetime resources being education, income and wealth.[30] Prior research, such as the literature review by Feinstein (1993), has generally found that education and income has an independent effect on mortality. However both have negative correlation with mortality rates.[31] It may be tempting to move from correlation to a causal relationship between education/income and differential mortality, but it is not a simple relationship. Considering health as the channel for mortality, international evidence suggest that health disparities are only partially mitigated when controls are included for access to health care and health risk behaviours (such as smoking and high-fat diet that are more prevalent among lower socioeconomic groups). The possibility of mutually reinforcing interactions among education, income, wealth, health and mortality make it very difficult to find a cause for differing health outcomes and consequently differential mortality. For a discussion on the interactions of these variables see Smith (1999).

New Zealand work has found similar results for the relationship between differential mortality and income,[32] see Blakely, Tobias, Atkinson, Yeh & Huang (2007) and Figure 10, noting that the increasing size in the differential seems to have slowed.[33] They also cite a previous report (Fawcett, Blakely & Kunst (2005)) which shows that differential mortality trends by level of education are broadly similar (that is higher education levels have an additional independent effect to reduce mortality rates). Their preferred relationship is income and mortality due to the changing profile of returns to education, as well as the increasing attainment of progressively higher levels of education over time.

With strong evidence to support differential mortality, and strong correlations to income and education the next part is how to incorporate differential mortality into a retirement income modelling framework.

8.1. Differential modelling framework

This section explains the methodology used to incorporate differential mortality into the projections. With the rather complicated interactions between differential mortality and other variables incorporated into the model, some assumptions are necessary to make including differential mortality tractable. There are three key assumptions, the first of which is that differential mortality is determined by the other demographic variables. The second assumption is that differential mortality has a proportional effect on the survival rates over the lifetime. The third is that differential mortality is linked to the final educational attainment and lifetime income.

The second and third assumptions deserve a more thorough explanation. With the links between education, income and mortality an individual's survival rates would be expected to vary over the lifetime as education

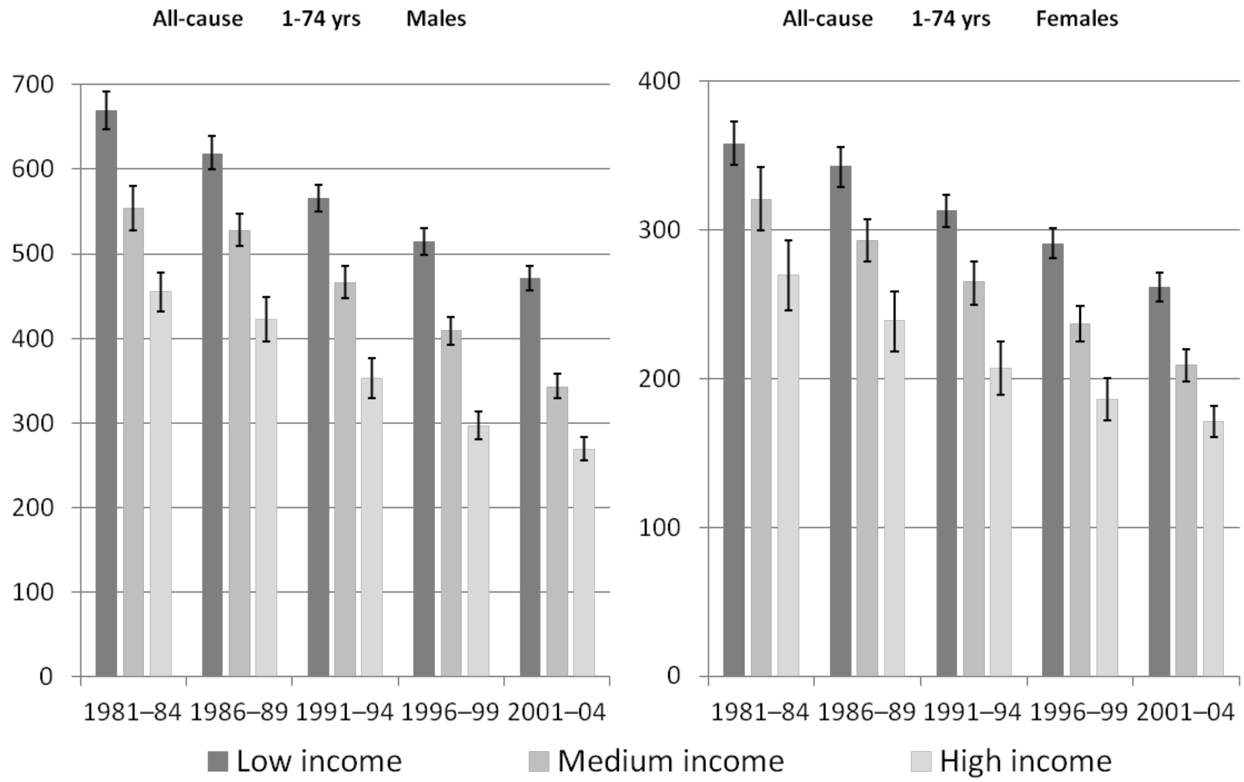
[30] Both in the New Zealand context and international studies ethnicity has also been explored as an explanatory variable for differential mortality. Given the lack of New Zealand ethnic population projections over the required time period, and some of the technical issues with the expansion in self-reported ethnic changes within New Zealand, this is beyond the scope of the current modelling approach.

[31] Income and education are generally positive correlation with each other, however there is evidence that the marginal return to an additional year of education may be decreasing over time as educational attainment increases.

[32] The definition of income used is equivalised household disposable income, which adjusts household disposable income (income after taxes and government transfers) by a factor that allows accurate comparisons based on estimated economies of scales in household consumption.

[33] Carter, Blakely & Soeberg (2010) find that the difference between life expectancies for the upper third of the income distribution and the lower third was 4.4 years in 1981 and 6.5 years in 2001.

Figure 10. Age-standardised mortality rates by income, New Zealand, 1981-2004



Source: Table S18, Blakely et al. (2007).

Table 10. Relationship between Education and Mortality: USA

	Mortality ratios			
	White men		White women	
Years of school completed	25-64 years	65+ years	25-64 years	65+ years
All persons	1.00	1.00	1.00	1.00
0-4 years	1.15	1.02	1.60	1.17
5-7 years	1.14	1.00	1.18	1.04
8 years	1.07	1.00	1.08	1.03
High school				
1–3 years	1.03	0.99	0.91	0.94
4 years	0.91		0.87	
College				
1–3 years	0.85	0.98	0.82	0.70
4 years	0.70		0.78	
	White men		White women	
	25-64 years	65+ years	25-64 years	65+ years
All persons	1.00	1.00	1.00	1.00
0–4 years	1.14	1.04	1.26	1.05
5–8 years	0.97	0.93	1.06	0.93
High school or college	0.87	0.97	0.74	1.01

Source: Feinstein (1993) summary of tables 2.1 and 2.2 in Kitagawa & Hauser (1973).

Table 11. Relationship between Income and Mortality: USA

<table>
<tr><th></th><th colspan="4">Mortality ratios</th></tr>
<tr><th></th><th colspan="2">White male family members</th><th colspan="2">White female family members</th></tr>
<tr><th>Family income</th><th>25-64 years</th><th>65+ years</th><th>25-64 years</th><th>65+ years</th></tr>
<tr><td>All persons</td><td>1.00</td><td>1.00</td><td>1.00</td><td>1.00</td></tr>
<tr><td><$2,000</td><td>1.51</td><td>1.10</td><td>1.20</td><td>0.96</td></tr>
<tr><td>$2,000–$3.999</td><td>1.20</td><td>0.99</td><td>1.12</td><td>0.96</td></tr>
<tr><td>$4,000–$5,999</td><td>0.99</td><td rowspan="2">0.92</td><td>1.00</td><td rowspan="2">1.05</td></tr>
<tr><td>$6,000–$7.999</td><td>0.88</td><td>0.98</td></tr>
<tr><td>$8,000–$9.999</td><td>0.93</td><td rowspan="2">0.96</td><td>0.92</td><td rowspan="2">1.01</td></tr>
<tr><td>$10,000 or more</td><td>0.84</td><td>0.86</td></tr>
<tr><td></td><td colspan="2">White male unrelated individuals</td><td colspan="2">White female unrelated individuals</td></tr>
<tr><td></td><td>25-64 years</td><td>65+ years</td><td>25-64 years</td><td>65+ years</td></tr>
<tr><td>All persons</td><td>1.00</td><td>1.00</td><td>1.00</td><td>1.00</td></tr>
<tr><td><$2,000</td><td>1.26</td><td>1.00</td><td>1.27</td><td>1.05</td></tr>
<tr><td>$2,000-$3,999</td><td>1.02</td><td rowspan="2">1.01</td><td>0.73</td><td rowspan="2">0.80</td></tr>
<tr><td>$4,000 or more</td><td>0.77</td><td>0.79</td></tr>
</table>

Source: Feinstein (1993) summary of table 2.5 in Kitagawa & Hauser (1973).

and income profiles change. This is challenging from a modelling perspective as it would require recalculating survival rates for every year, while still maintaining consistency with the aggregate differentials, that is ensuring that two people who end up with the same educational attainment and lifetime income have the same differential mortality. By linking the differential to the final outcome of lifetime income and educational attainment and smoothly altering survival rates we maintain consistency with the aggregate differential while still capturing the important individual effects of differential mortality.

The final mortality differential for person i is calculated as:[34]

$$\Delta\text{Mortality} = 0.5(\text{Education}_i - \mu_{\text{Education}}) + 3\min\left(\sqrt{\frac{\text{Lifetime income}}{GM_{LI}}} - 1, 2\right)$$

where $\mu_{\text{Education}}$ is the average education level of the individuals cohort and GM_{LI} is the geometric mean of lifetime income of the individuals cohort. The parameters of 0.5 for education and 3 for income were chosen using expert judgement informed by the evidence presented. With differing definitions of income and education, as well as a different reference point, it is not possible to reconcile the differential mortality estimates for New Zealand with the projection methodology.

With the mortality differential all that remains is to modify the survival rates appropriately. All of the modifications to survival rates begin at age 15, from which using the assumptions detailed above we can modify the survival rates. The idea is to “shift” the survival curve by the mortality differential, substituting 1 for each year of positive mortality differential. This transformation ensures that the life expectancies are consistent, survival rates are possible (≤ 1) and the change occurs in the area of the distribution that has the least effect to our retirement income measures as starting survival rates for 15-25 year olds are all above 0.999.

9. Applications of the retirement income model

This section presents aggregate fiscal costs for four types of policies that have been evaluated with this model, raising the age of eligibility for NZS, changing the rate of annual adjustments, communal prefunding from a payroll tax and compulsory private savings with abatement, funded from a payroll tax.

[34] For cohorts that are aged over 40 in 2010/11 only the education term is used, with a constant of 0.75 replacing 0.5.

9.1. Age of eligibility

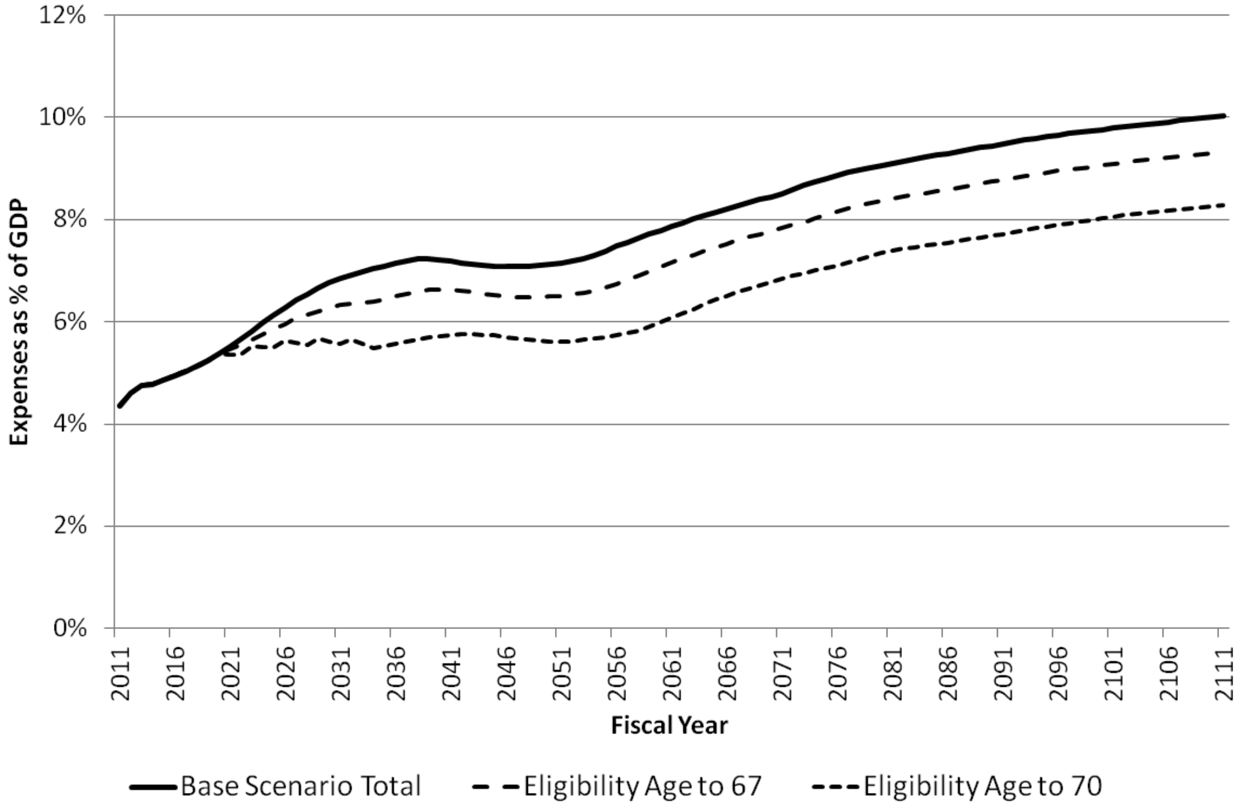
One of the broad choices presented in Kirkup et al. (2012) is to alter the coverage of NZS to reduce the fiscal cost. There are many ways this could be accomplished, such as making the residency requirements tighter or raising the age of eligibility. As an increase in the number of recipients due to an increase in life expectancy is a significant driver for the increasing fiscal cost, this option is an attempt to ensure that different age cohorts spend a comparable proportion of their life receiving NZS.

As of June 12, 2013 the age of eligibility for NZS is 65, and is not projected to change, which is consistent with current policy. The age of eligibility for NZS is also explicitly linked with the age of eligibility for withdrawing KiwiSaver, which is important when considering the interactions with the public and private prefunding options. Note that only age of eligibility *increases* are currently supported, and currently it is not possible to have separate eligibility ages for KiwiSaver/compulsory savings and NZS.

There are two options when modelling an age of eligibility increase with this model, one is to specify a rate of increase up to a specified age (for instance 2 months per year until the age of eligibility reaches 67) and other is to specify a custom age track, which allows more flexibility. The output from the model for the changes in hte age of eligibility for NZS is shown in Figure 11.

When the age of eligibility is not an integer, the fractional part is used to determine the proportion of the cohort who receive it in the first year, with the remainder receiving NZS in the subsequent year. For instance if the age of eligibilty was 65 years and 2 months then in the cohort turning 65 in the year, 2/12-ths would not be eligible and the remainder would be. Individuals are allocated using a Bernoulli variable with the appropriate parameters of success p determined by the fractional part of the age of eligibility.

Figure 11. Age of eligibility scenarios for NZS



Source: Author calculations

9.2. Annual adjustment of NZS

In the base model it is implicitly assumed that NZS is indexed to economy-wide wage growth,[35] which is the same assumption used to drive the cohort wage growth of the income component of the model.[36] This is the other significant driver of the increased fiscal cost, as the payments given to NZS recipients are rising faster than prices. With this option we would expect to see lower retirement incomes for the elderly, and unlike the other options presented this one affects existing superannuitants who may not have the ability to alter their behaviour by working longer or saving more, implying that consumption will likely decrease for this cohort.[37]

There are three main parameters that can be changed which affect the annual adjustment of NZS, economy-wide wage growth, CPI and the mixing parameter which represents what proportion of wage growth and CPI is used for indexation (1 is full wage growth, 0 is full CPI growth and in principle and number could be used outside of $[0, 1]$ to get the required growth rate).

The final modification that can be made to the annual adjustment has a base payment that is received upon reaching the age of eligibility with one indexation, and then every year after receiving the base payment follows a separate indexation regime. The best example of this is the U.S. system which the base payment is wage indexed, and after receiving this it is adjusted by CPI, which generally results in all subsequent cohorts receiving higher payments than their predecessors. There is also a consistency parameter that is including in prefunding options that adjusts wage growth when compulsory savings schemes with an obligation on the employer reduces wage growth for the employee to compensate. This is also flowed through to NZS annual adjustments, as it would under current policy if wage growth was affected.

The scenario presented compares the base scenario with CPI inflation indexing of NZS rates and indexing hte rates to a 50% mixture of CPI inflation and economy wide wage growth. This is presented in Figure 12.

9.3. Communal funding

There are further options that involve changing how NZS is funded, moving from the current system which is dominated by contemporaneous taxation to a system which involves pre-funding. Communal pre-funding in the New Zealand context would most likely involve an expansion of the New Zealand Superannuation Fund, above and beyond the capital contributions that have already been committed under current policy. Communal prefunding will most likely increase the total amount available for a given cohort through compounding returns. This will also cause some cohorts to effectively pay for part of the previous cohorts tax financed NZS and part of their own future NZS, which is substantially more than some previous cohorts would have contributed.

One of the driving policy changes that lead to the creation of this model is communal prefunding of NZS from a payroll tax. Communal prefunding does not necessarily reduce the future NZS liabilty, as it does not by itself change the number of recipients or the rates.[38] What communal funding does, similar to private prefunding, is to sacrifice consumption in the present for increased consumption in the future. One of the key assumptions underlying this is that the rate of return to capital will be higher than the growth rate of the

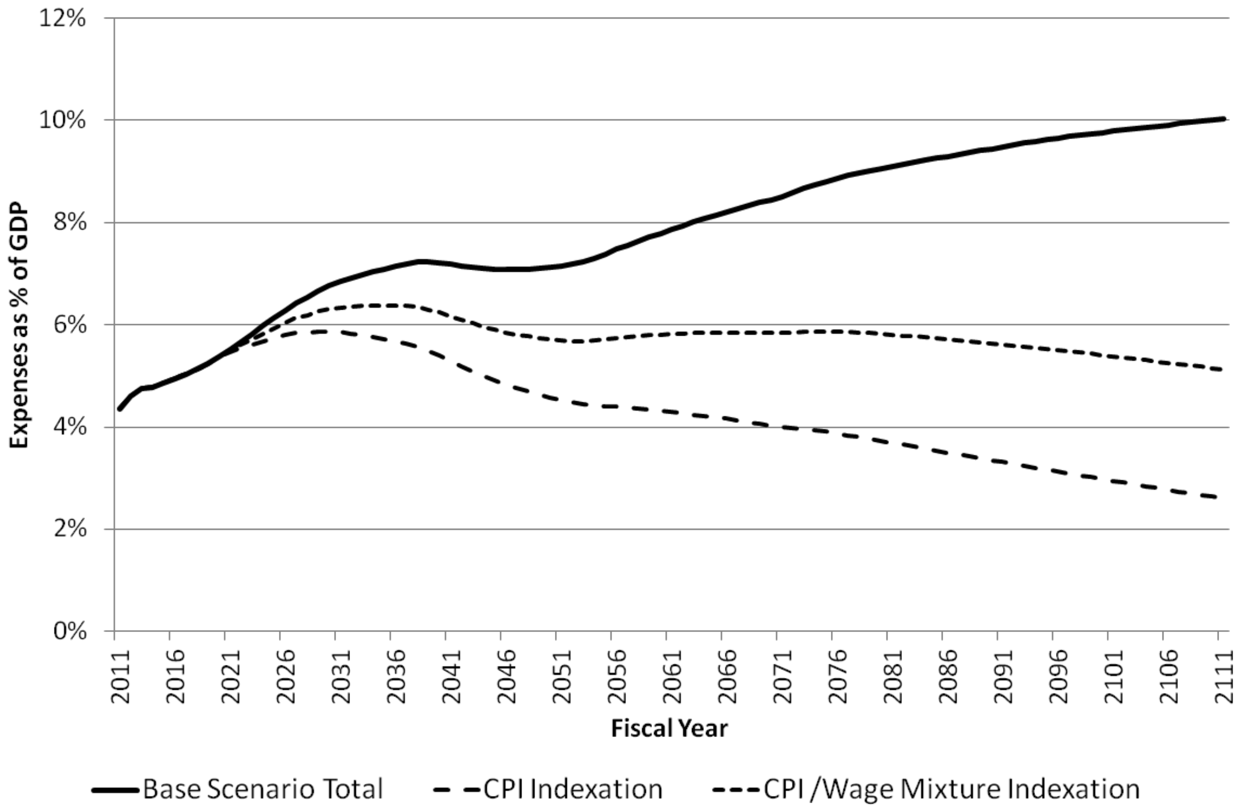
[35]This is due to the differential between CPI inflation and wage growth causing NZS to remain on the legislated wage floor over the projection period.

[36]This may seem to lead to a slight inconsistency in that aggregate wage growth from the income model is not the wage growth used to adjust NZS, however the wage growth used for adjusting NZS does not depend on the hours worked whereas economy-wide wage growth implied by the income component does. The differences are ± 0.05% for the period 2010/11 to 2060/61 which is not unreasonable to ignore considering the variability in wage growth over the last 20 years.

[37]There are other avenues, such as decumulation of assets, the important point is that existing superannuitants will be under more financial pressure relative to the other options presented.

[38]This is not entirely true as the implementation of a payroll tax would reduce the net of tax average wage, similar to the ACC levy, which would reduce the wage floor lowering the cost of NZS. This could be offset by reducing personal income rates to ensure that marginal tax rates remain constant. There may also be savings impacts, through avenues such as capital deepening, which could increase future productivity growth and real wages and consequently increase the rates and liability of future NZS.

Figure 12. Scenarios for indexation changes to NZS rates



Source: Author calculations

economy, and arguments for converting to a Save As You GO (SAYGO) scheme are covered in Coleman (2011, 2012).

The first and most important choice for the modelling of communal funding is to decide how to decumulate the savings to offset NZS costs. The option considered is to construct separate accounts for each cohort, and to purchase annuities for all remaining survivors at the age of eligibility for the cohorts account balance. Any shortfall would be covered by the government through contemporaneous taxation, and any surplus would be available to the government. The other parameters included in the model which are relevant to the communal funding option are the payroll tax rate and the rate of return.

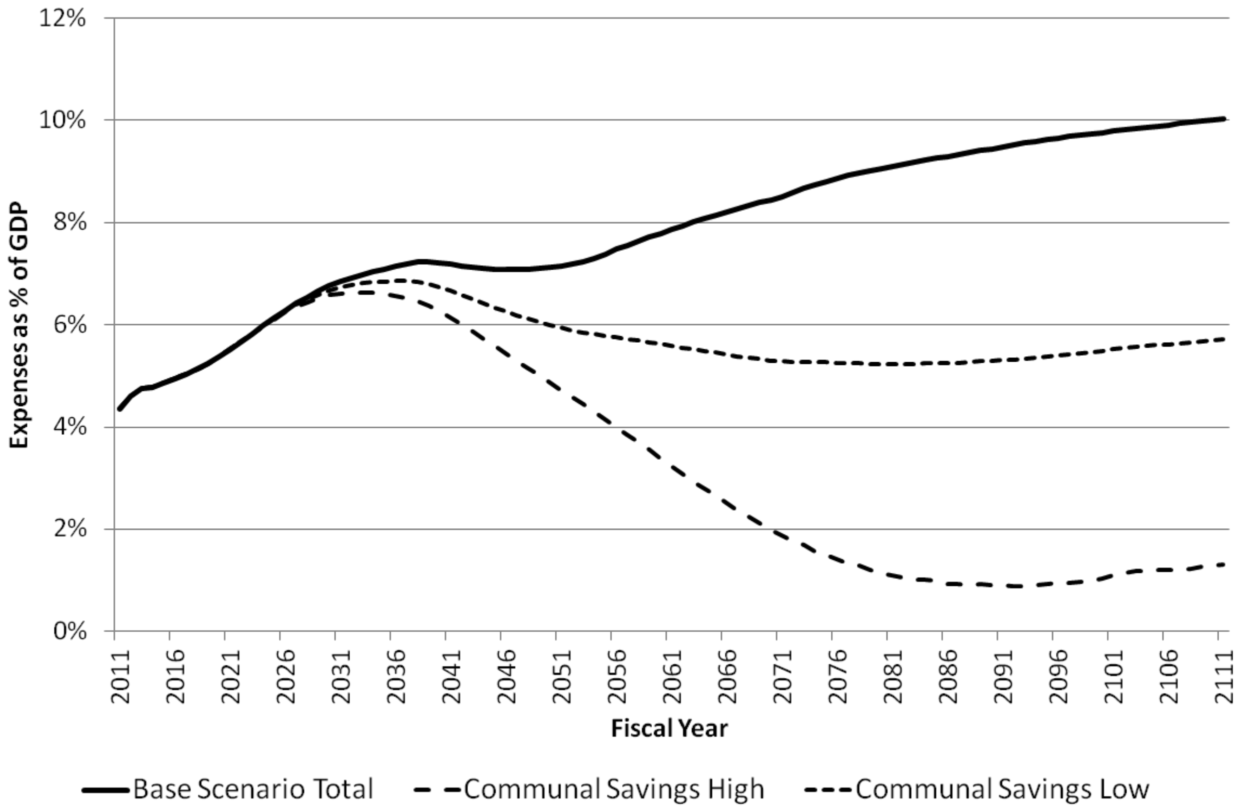
The annuities considered are actuarially fair-value individual annuities priced by gender (women tend to live longer which results in an increased fair-value cost for an annuity of the same payment per period relative to a male in the same cohort). The cohorts account is split to the survivors at the age of eligibility in such a way that everyone receives an annuity with the same payment per year. The scenario presented is the base scenario against a 3% and 6% payroll tax, shown in Figure 13.

9.4. Compulsory private savings with abatement

The final option considered is abatement of a compulsory private savings, similar to a compulsory version of KiwiSaver where a percentage of the balance at retirement is used to purchase an annuity,[39] with the government providing a top-up if necessary to ensure that everyone receives at least the current level of NZS. Compared to communal pre-funding this will more closely align contributions with retirement income outcomes as higher earners will receive higher levels of retirement income. For a more thorough treatment of compulsory private

[39] As with communal funding the annuity is assumed to be purchased at an actuarially-fair price based only on pricing by gender.

Figure 13. Scenarios for communal funding of NZS



Source: Author calculations

savings with abatement refer to Kirkup et al. (2012).

Almost all of the considerations and parameters transfer over to this case from communal pre-funding, however we have added a split between the amount contributed by the employee and the amount contributed by the employer. The justification is that employer and employee contributions mayo have different macroeconomic impacts on, for example wage growth. For the scenarios presented here we have assumed that there are no macroeconomic impacts from either employer or employee contributions, however we have run scenarios where we have assumed differing impacts on wages and GDP.

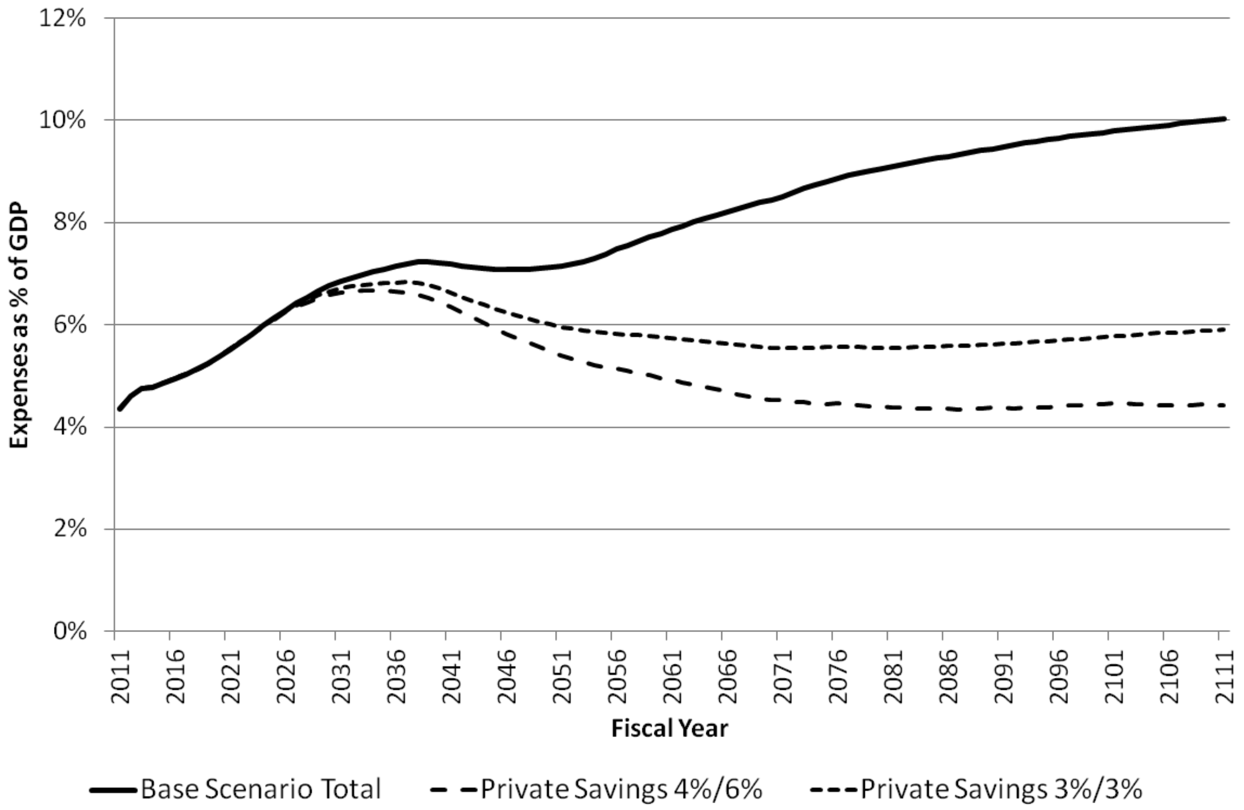
The two compulsory private savings scenarios presented are an implementation of a 4% contribution from the employer and a 6% contribution from the employer, with 50% of the balance at the age of eligibility used to offset government NZS expenses, and a scenario with a 3% contribution from both the employer and employee with 50% offset. Note that in both scenarios if the person dies before reaching the age of eligibility then no money is taken from the account, unlike the communal funding scenarios.

10. Conclusions

The model presented in this paper provides a framework for analysing a broad range of policy options for New Zealand Superannuation. It brings together previous work to project additional demographic indicators, such as education and couple status, and link this together with a consistent method of projecting income. The approach presented can be used to present detailed disaggregation of fiscal measures and distributional analysis, beyond what has been previously available for New Zealand.

Analysing policy options for retirement income is very difficult. The model presented in this paper makes

Figure 14. Scenarios for abatement of private savings to partially fund NZS



Source: Author calculations

a valuable contribution by providing a consistent framework for analysing a range of policy options, some of which have been presented in the previous section. Explicit policy recommendations are not the primary purpose of this model, and wider considerations than what have been considered here are needed before any policy could be implemented.

What this model provides is a useful way of comparing the fiscal costs, from which some conclusions can be derived. Firstly, of the four options presented changing the age of eligibility is the only one which will give short term savings, however compared to the other options the long term savings are more moderate. Secondly, while changing the indexation and pre-funding have similar fiscal cost profiles, the level of payments and incidence of taxation can be significantly different. Finally, the microsimulation approach presented in this paper can be a useful tool analysing retirement income policy, although the full strength of this approach has not yet been used to date.

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