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New Treasury Stochastic Modelling of Australian Retirement Incomes

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NEW TREASURY STOCHASTIC MODELLING OF AUSTRALIAN RETIREMENT INCOMES

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Purpose of paper: We look at the distribution of retirement outcomes generated by linking Treasury's hypothetical retirement model RIMHYPO with a Wilkie-type stochastic model of economic parameters.

Synopsis: At an Institute of Actuaries of Australia seminar in November 2009, Colin Grenfell challenged Treasury to produce a stochastic version of its retirement income projection model, RIMHYPO. This paper reports on the methodology and results from making this improvement.

RIMHYPO (Retirement Income Model-Hypothetical) models an individual or couple's superannuation and disposable income throughout their working life and retirement. It covers the relevant superannuation, personal tax and social security rules and allows for a broad range of financial products in retirement. The key wages and investment growth parameters are fixed by users.

In the new version of the model, stochastic volatility is introduced to three key parameters: inflation, wage growth and investment returns. This is done using a Wilkie-type model, which captures cyclical behaviour as well as correlation between these parameters, recalibrated to Australian data by Butt and Deng (2010). Some transparent adjustments are made to improve consistency with other estimates.

We report the resulting spread of outcomes such as replacement rates, retirement payouts, and average retirement expenditure. This is contrasted with the deterministic model's results.

The model gives Treasury greater scope for policy analysis. For example, the paper investigates the use of 'expected years of ruin' as a metric for deciding portfolio allocation in the presence of the Age Pension.

1. Introduction

The adequacy of incomes in retirement is a topic of great interest to many Australians. Hypothetical modelling can help inform discussion and policy development, and Treasury's RIMHYPO model has been used extensively for this purpose over many years.

Analysis of retirement incomes has increasingly focused on risks, for example investment risk (the risk that a person's savings do not perform to expectations) and longevity risk (the risk that a person outlives their savings). In the Australian retirement income system, individuals directly bear significant investment and longevity risks through the superannuation system. This is not the case in 'social security' type schemes that can be found in Europe, for example, which typically promise lifetime benefits regardless of any investment performance, and rely on the government's continued ability to meet this promise. However, the Australian system is also unusual in having a relatively large publicly-provided means-tested Age pension, which forms a significant part of most retiree's income (and will continue to do so, even as the superannuation system matures – see the 2010 Intergenerational Report). Through the Age pension, the government indirectly bears significant investment and longevity risks.

Traditional hypothetical modelling, using assumptions about future economic conditions, is less suited to the analysis of risks in the system. This paper presents initial results from a version of RIMHYPO that has been linked to a stochastic model of future economic conditions, with the resulting spread of outcomes allowing the development of a richer picture of possible future outcomes.

Part 2 introduces RIMHYPO and the stochastic model of economic conditions it was linked to, namely Butt and Deng's parameterisation of a Wilkie-type model (Butt and Deng, 2010). Part 3 then compares the results of the linked model to results from a standard RIMHYPO run. In part 4, the effect of the Government's announced increase in the SG rate is explored, while part 5 investigates how the Age pension 'cushions' variations in the performance of private savings. Part 6 concludes by briefly discussing the merits of various metrics for assessing portfolio allocation strategies.

2. Models used

RIMHYPO is Treasury's hypothetical model of retirement outcomes. It was developed by the Retirement Income Modelling (RIM) Taskforce who were given the task of "develop[ing] a capacity for modelling the impact of retirement income policies over the next half century". A wide variety of cameos can be modelled - single people and couples; people with different income levels, including periods of unemployment or disability; and people with different savings patterns inside and out of superannuation (including home-ownership). In retirement, a range of financial products can be taken, such as allocated pensions, various annuities, term deposits or some combination of these. Future life expectancy is taken from RIM's demographic models, although users can specify actual longevity if they wish.

Once a cameo has been defined, the model then steps it through year by year. Each year various outcomes such as earnings, superannuation contributions and other savings are calculated. The model faithfully applies the relevant 'rules' of the tax and social security systems, as well as the laws governing the superannuation system. In this way a comprehensive picture of financial outcomes throughout work and retirement can be built up. While the model can replicate the regulatory system in place at the time it was first built, it has been updated over the years to incorporate more recent policy developments. The version used for the analysis presented here

includes the Better Super changes, other developments such as the Government super co-contribution, and the announced low-income superannuation rebate.

RIMHYPO has been extensively used in the development of retirement incomes policy, particularly in assessing the adequacy of retirement income outcomes for cases of interest. Previous results have been reported for example in Tinnion and Rothman (1999), and Rothman and Bingham (2004). The model allows the impact of mature policies to be tested even though policy changes in this area typically take many years to become fully established. More recently, RIMHYPO informed the design of the Better Super changes, and was also used by the Australia's Future Tax System panel to demonstrate the effects of their retirement income system recommendations. In turn, the Government's response to the AFTS report, in particular the decision to raise the Superannuation Guarantee rate from 9 to 12 per cent and the adoption of the superannuation low-income rebate, was informed by further RIMHYPO modelling.

The long term nature of RIMHYPO cameos (which typically encompass around 70 years, finishing beyond the year 2050) necessitates users making assumptions about the future path of key economic series such as inflation, wage growth and investment returns. These assumptions are informed by historical experience, as well as judgements about the impact of developments such as an independent Reserve Bank and population ageing. Similar assumptions underpin the regular Intergenerational Reports (Australian Government 2010a), where they are discussed in more detail.

An alternative approach to using fixed assumptions about future economic conditions is to employ a model that creates plausible future scenarios that are not directly determined by the user. With this approach a number of 'futures' can be modelled, allowing the user to explore how their results respond to plausible variations in conditions, and generating a 'spread' of outcomes rather than a single best estimate. Retirement system modelling using this stochastic approach has been explored by Grenfell (2010) for example, and was also employed by the Australian Government Actuary in commissioned work for the Cooper Review (Super System Review Final Report, Australian Government, 2010b). This type of modelling aims to better present the risks around a particular outcome, in a sense by undertaking a large number of sensitivity analyses.

The current paper presents some results from linking RIMHYPO to such a stochastic model of economic conditions. Following the Australian Government Actuary's work for the Super System (or Cooper) Review, the Wilkie framework was employed to generate stochastic economic series. This framework was chosen as it is well known, as well as being simple to understand and implement. It is based on a 'cascading' structure, in which inflation is modelled first, and then other series are generated taking account of the modelled inflation outcomes. This builds in correlations between the stochastic series, just as correlations are present in the actual historical data. For example, the equation that was used to generate wage growth modelled it as a margin above inflation (plus a random shock). As well as correlations between series, the Wilkie framework aims to capture the cycles seen in the historical data. To this end, series typically depend on their lagged values (and the lagged values of other series with which they are correlated). At each level of the 'cascade', random perturbations are introduced to give appropriate variability.

Butt and Deng (2010) estimate a Wilkie model using Australian data, and their work is used here. It generates inflation growth, wage growth, international and Australian equity returns, international and Australian bond returns, and cash returns. Due to difficulties in estimation, it does not include real property, although this absence is not noticeable when looking at overall portfolio returns. Butt and Deng use almost 30 years of data to estimate the model parameters, and make no further adjustments. As a result, the inflation series tends to be higher than would be reasonably expected given the Reserve Bank's inflation target band. For this reason, and following Butt and Deng, this

paper focuses on real results. Further, the purely data-driven wage growth parameters gave very low real wage growth. To enable wage growth scenarios that are more consistent with other long term estimates (such as the Intergenerational Report), the estimated margin of wage growth above inflation given by Butt and Deng was artificially increased. This seems a more transparent adjustment than re-estimating the parameters over a more favourable period.

Following Butt and Deng, a ‘growth’ portfolio is defined, comprising 58.33 per cent Australian equities, and 41.67 per cent international equities. Similarly, a ‘defensive’ portfolio, comprising 30 per cent Australian bonds, 20 per cent international bonds, and 50 per cent cash, is calculated. These proportions are informed by Australia Prudential Regulation Authority (APRA) data on the average asset allocation of default options in Australian super funds. Each cameo then holds a certain proportion of their assets in the ‘growth’ portfolio, and the remainder in the ‘defensive’ portfolio. For example, a cameo with 65 per cent exposure to growth assets holds 37.9 (= 65% × 58.33%) per cent in Australian equities, and 17.5 (=35% × 50%) in cash. This portfolio is assumed to be rebalanced each year to maintain this constant exposure to risk, regardless of the performance of any of the components. Relatively high levels of investment fees are used to dampen equity returns, contributing to modelled returns that are more consistent with standard Treasury assumptions. Fees are calculated separately for the ‘growth’ and ‘defensive’ portfolios, and are set at 3.6 and 1.4 per cent per annum respectively. This means a cameo with 65 per cent exposure to growth assets pays investment fees of 2.8 per cent per annum on the gross returns from the model.

Table A presents key statistics about the Wilkie model’s output over 1000 independent runs, each of 61 years length. ‘Real mean growth’ is calculated by taking the arithmetic mean of the 1000 geometric means of real growth (computed for each independent run). Similarly, the median real growth is the median of the 1000 geometric means. Real growth is focused on, as average inflation growth in the model (calculated in the same way) is 3.56 per cent, which is outside the Reserve Bank’s target band. For comparison, the corresponding nominal figure in a 2.5 per cent inflation environment is also given. Portfolio returns in the table are calculated after fees but before taxes.

Table A. Average real growth across 1000 different runs

	Mean real growth	Median real growth	Nominal mean growth (a)
Wages	1.61%	1.60%	4.15%
Defensive assets	1.65%	1.65%	4.19%
Growth assets	5.04%	5.05%	7.67%
Portfolio (65% growth)	4.37%	4.41%	6.98%

(a) In a 2.5 per cent inflation environment

Note: Investment returns are after fees but before taxes

These results are broadly consistent with other plausible and defensible estimates of future returns. For example, FIDO calculators prepared by the Financial Literacy commission use a 4.8 per cent real return for growth assets before fees, and a 1.9 per cent real return for capital guaranteed (defensive) assets before fees. In their recent report ‘Superannuation Savings Gap 2009’ RiceWarner Actuaries used an assumption of a 7.5 per cent nominal return on superannuation savings before fees and taxes. The Industry Super Network calculator uses an average nominal return of 7.225 per cent after taxes but before fees.

The differences between mean and median returns in Table A are a simple measure of the variation in returns between runs. Table B presents some other measures of the variation between runs, and also within runs. Again, the standard deviation of the 1000 geometric means was calculated as a measure of the variability of average growth in each run over all the runs. For each run, the standard

deviation in real growth was calculated, and then the arithmetic mean of this figure across the 1000 runs was taken as a summary statistic of the average variability within each run.

Table B. Variation in the Wilkie model output

	Standard deviation of the 1000 geometric means (percentage points)	Mean of the 1000 standard deviations (percentage points)
Inflation	0.76	2.29
Wages	0.47	1.95
Growth assets	2.25	23.66
Defensive assets	0.88	2.60

Note: Investment returns used were after fees but before taxes

Once the Wilkie model had produced these 1000 independent possible economic futures, they were fed into RIMHYPO to model the resulting financial outcomes in retirement. The same 1000 runs from the Wilkie model were used for every cameo type reported below, so that any differences in outcomes were due to differences in the characteristics of the cameos, rather than different economic trajectories.

Simulated economic conditions from the Wilkie model not only affected the wage growth and investment returns of the individuals in each cameo, but could also affect system parameters. For example, there is a legislated link between the maximum rate of the Age pension and average wage levels¹. As such, differential wage growth could impact on a person's financial position in retirement both directly, through affecting the amount of SG contributions made to superannuation on their behalf under the SG, and indirectly, through the level of Age pension that was available to them in retirement. Similarly, the inflation simulated in the model had an impact on the Age pension means test settings, as well as the real value of savings.

In RIMHYPO, rather than exhaustively model the taxation of investment returns, assumed effective tax rates were used. Superannuation funds can receive refundable franking credits in respect of franked Australian dividends which can substantially lower their effective rate of tax. Similarly, they only include two thirds of any nominal capital gains in their taxable income, which again lowers their effective tax rate. While the Wilkie framework that was used allows the level of Australian dividends to be isolated, and so franking credits could theoretically be modelled, it does not split the return on international equities between dividends and capital gains. Similarly, modelling the carry-forward of capital losses would not be straightforward, particularly given the level of freedom that super funds enjoy in deciding when to crystallise any losses (they may be able to meet any financial obligations through present contributions, for example). For these reasons, effective tax rates were chosen as a simple alternative. The tax rates used depended on the headline rate faced by the fund and the assumed exposure to growth assets (and so franked dividends and capital gains). For the 65 per cent exposure to growth case, the effective tax rate was assumed to be 7 per cent in the accumulation phase, and -7 per cent in the drawdown phase.

For cameos that involved the Superannuation Guarantee rate increasing from 9 to 12 per cent, as announced by the Government in response to the AFTS report, wage growth from the Wilkie model was manually lowered over the period the SG rate was phased up. This is consistent with an assumption that the SG is incident on employees rather than employers.

¹ The maximum rate of a single Age pension is set at 66.33 per cent of the combined couple rate by legislation. In turn, legislation provides that the combined couple rate cannot fall below 41.76 per cent of Male Total Average Weekly Earnings (MTAWE).

3. Adequacy results

This section reports the main results from linking Butt and Deng's parameterisation of the Wilkie model with RIMHYPO. The distribution of replacement rates and average retirement expenditure is explored, as well as how these distributions shift under a move to an SG rate of 12 per cent. Further, the effect of the Age pension, particularly in cushioning the variation in private spending, is analysed.

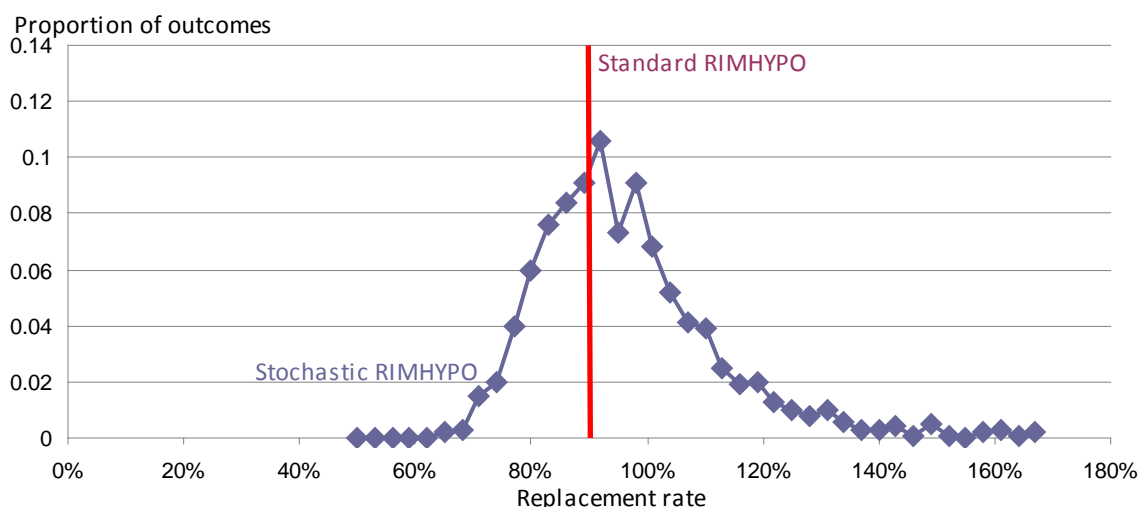
The main cameo is of a single female, who commences in her super fund aged 30 in 2010. While working she earns 75 per cent of annualised Average Weekly Ordinary Time Earnings (AWOTE), which is roughly median earnings. She retires at age 67, when she puts all her super into an allocated pension. From this she draws down an amount each year that is halfway between the legislated maximum and minimum drawdown amounts that would apply to similar income streams started before 2006 (following the introduction of Better Super, there are no longer maximum drawdown limits). Throughout her life, she maintains a 65 per cent exposure to growth assets. By the point of retirement she owns her house.

Longevity risk is not modelled, so in each run she dies aged 91 (being her projected life expectancy at retirement). An obvious extension of this analysis would be to allow her year of death to vary between runs – this is left for future work, and the focus for now is placed solely on investment risk.

Retirement outcomes are typically presented in either real average annual retirement expenditure or replacement rate terms. Calculating real average annual retirement expenditure involves bringing back her disposable income in each year of retirement to 2010-11 dollars using the inflation rate in that particular run, and then computing the (arithmetic) mean of these figures. The replacement rates presented here measure this real average annual retirement expenditure as a proportion of her real disposable income in her final year of work. As such, they measure the extent to which pre-retirement spending can be maintained once work has ceased, and so give a better indication of consumption smoothing than a simple average expenditure amount can do. Most commentators recognise that replacement rates of less than 100 per cent are adequate, as certain costs associated with work no longer need to be met in retirement. It is worth noting that neither replacement rates nor average expenditure measures align perfectly with consumption, as non-cash benefits such as subsidies on PBS medicines or the imputed rent a home-owner enjoys are not captured.

Chart A shows the distribution of replacement rate outcomes for this cameo, under the announced move to a 12 per cent SG rate.

Chart A. Distribution of replacement rate outcomes

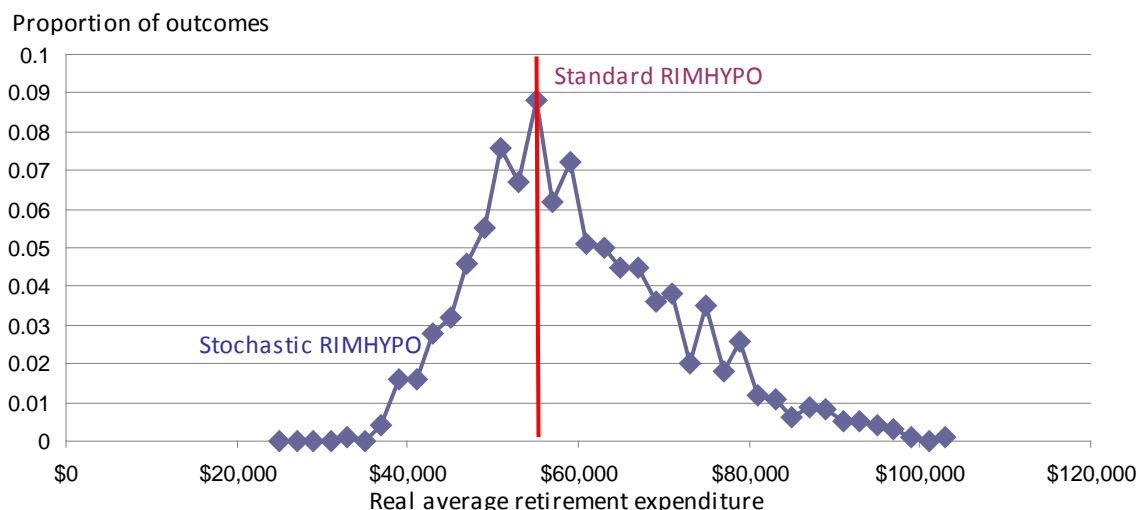


The median replacement rate is 92.0 per cent, with the mean at 95.1 per cent and a standard deviation of 16.5 percentage points. Overall, the distribution is skewed upwards, with the 25th percentile of runs 7.5 percentage points below the median, whereas the 75th percentile is 10 points above the median. Thus the central 50 per cent of runs have replacement rates between 84.5 and 102.0 per cent. This skewed distribution is consistent with the lognormal distribution of returns from the Wilkie model. It is also consistent with the presence of the Age pension, which provides a significant safety net in the event of poor investment returns. While it would be unwise to place too much weight on outliers, there is clearly a significant tail of runs which enjoy a replacement rate above 100 per cent.

These outcomes are shown compared to a standard RIMHYPO run, where inflation was set to 2.5 per cent, wages growth to 4.14 per cent (consistent with the Intergenerational Report), and nominal investment returns (after fees but before taxes) of 6.5 per cent. This run lies very close to the median of the stochastic runs, at the 49th percentile.

Chart B shows the distribution of real average retirement expenditure.

Chart B. Distribution of average real retirement expenditure



This is a comparable shape to that shown in Chart A, which is unsurprising given the close relationship between the two measures. Again, the distribution is skewed upwards, with the median run coming in at \$57,300, the 25th percentile \$6,800 below this, while the 75th percentile is \$9,600 higher. As before, this bias can be attributed to the lognormal returns from the Wilkie model and the influence of the Age pension, which provides a floor to retirement expenditure even when private savings perform very poorly. The mean real average retirement expenditure is \$59,500, and the standard deviation is \$12,900. As with the replacement rate, the result from the standard RIMHYPO run described above lies close to the median, at the 52nd percentile of the stochastic runs.

4. The effect of an increase in the SG rate

Hypothetical modelling of retirement outcomes can be used to assess the impact of changes in the policy environment. As an example, the recent Government decision to lift the SG rate from 9 to 12 per cent is now analysed. This decision was driven by a desire to increase the adequacy of financial outcomes in retirement for workers – “the Government’s approach to superannuation will achieve ... greater adequacy” (Australian Government, 2010c). Using the same cameo as before, the modelled effect on the distribution of retirement outcomes is shown in Chart C.

Chart C. Distribution of replacement rate outcomes, by SG rate

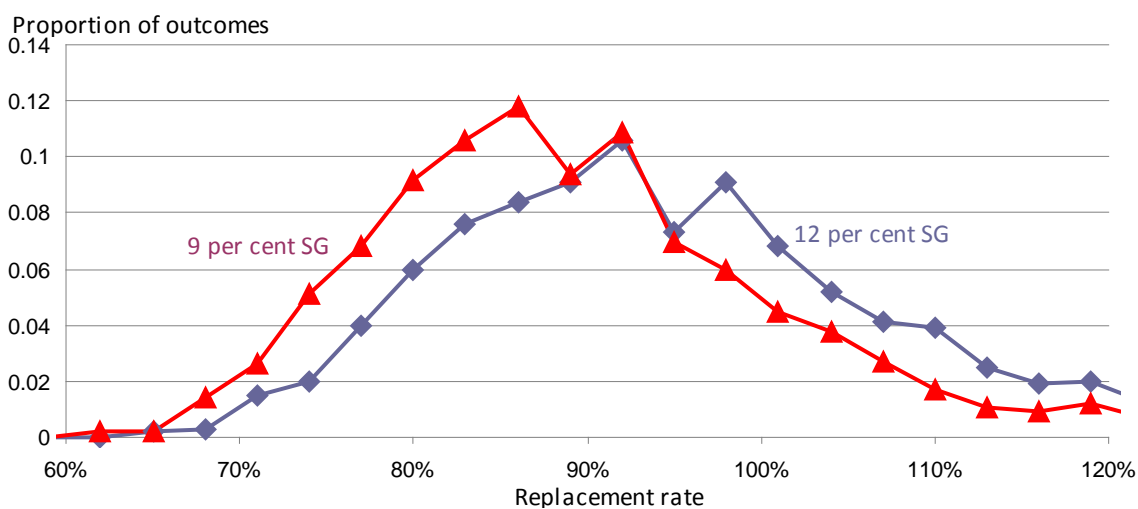
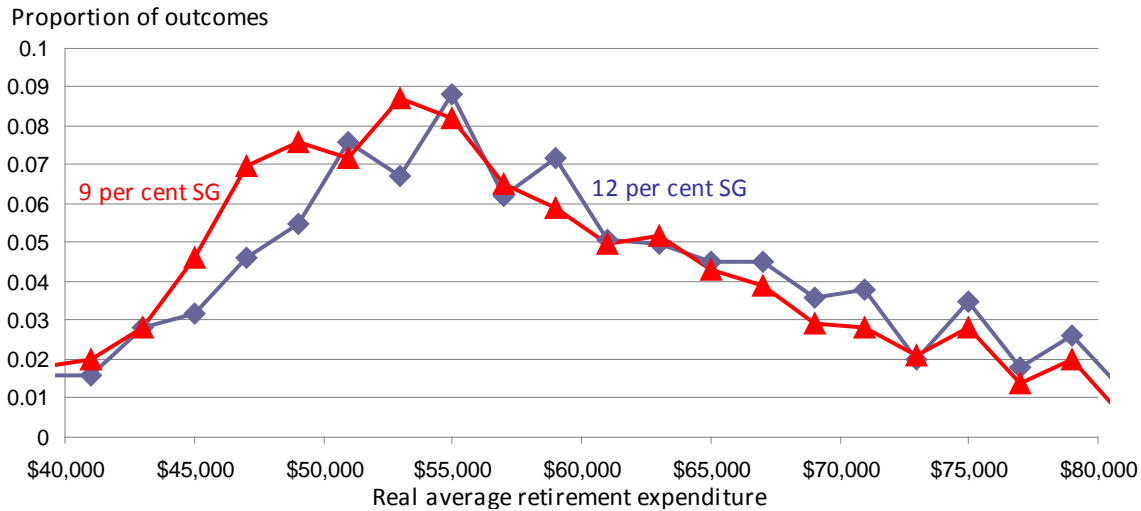


Chart C clearly shows that the increase in SG rate shifts the distribution of outcomes to the right, indicating an increased likelihood of higher replacement rates as expected. Indeed, the median replacement rate is 5.6 percentage points higher after the increase. The 25th percentile of replacement rate outcomes has increased from 79.9 to 84.5 per cent. This represents a significant drop in the proportion of stochastic runs that exhibit a replacement rate below 79.9 – falling from a quarter of the runs under a 9 per cent SG rate to just 13.7 per cent after the increase.

Turning to real average retirement expenditure, Chart D illustrates the modelled shift in the distribution of outcomes under the SG rate increase.

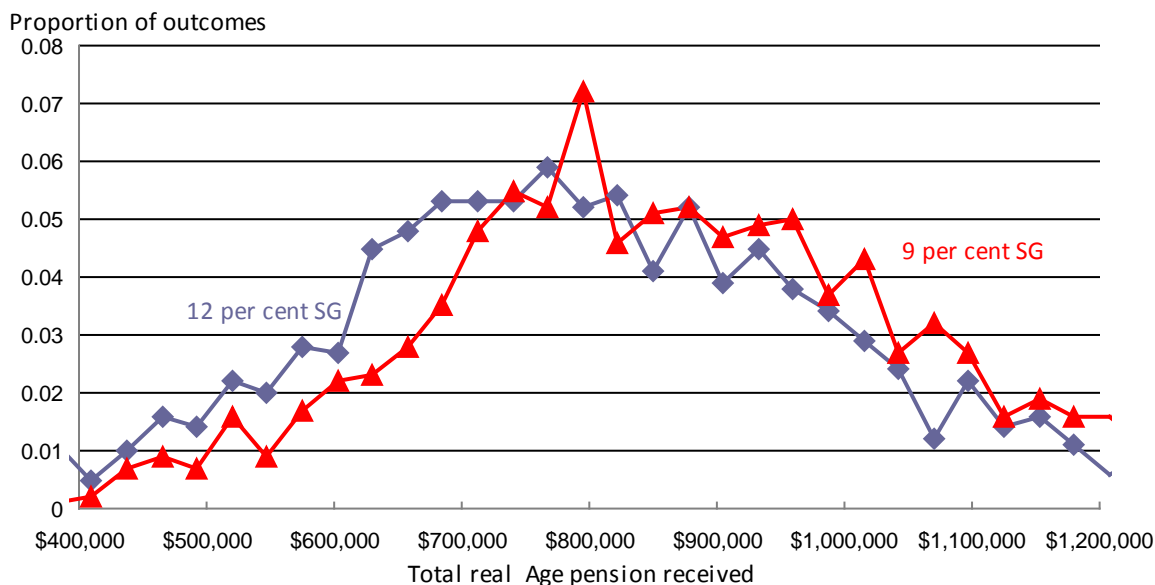
Chart D. Distribution of real average retirement expenditure, by SG rate



Again, the boost to retirement incomes adequacy is clearly visible, with the median real average retirement expenditure rising by more than \$2,500 after the change. The proportion of stochastic runs with real average retirement expenditure below \$48,500 falls from 25 per cent to 18.4 per cent.

Finally, the total real Age pension receipt for this cameo is compared under 9 and 12 per cent SG rates (Chart E).

Chart E. Distribution of total real Age pension receipt, by SG rate



From Chart E it can be seen that the increase in SG rate tends to reduce the total amount of Age pension that is paid to this cameo type, although there remains significant Age pension receipt even after the change.

Part of the reason for the high levels of Age pension receipt is the assumed drawdown profile in the cameo, which brings private savings down such that by the age of around 82 the female in the cameo receives a full-rate Age pension. As the Age pension grows in real terms over time (through its link to average wages), these later years of Age pension receipt occur when the Age pension is at its highest level in real terms. Another factor in the high levels of Age pension receipt is the Seniors Supplement, payable to holders of the Commonwealth Senior’s Health Care card, which is included in the Age pension total in this analysis. Worth \$816.40 per annum at 20th March 2011 (and indexed), it is means-tested using taxable income (and without any assets test). As a result, even runs which are enjoying strong returns and significant drawdowns from their allocated pension still qualify, as these drawdowns are tax-free following the Better Super changes.

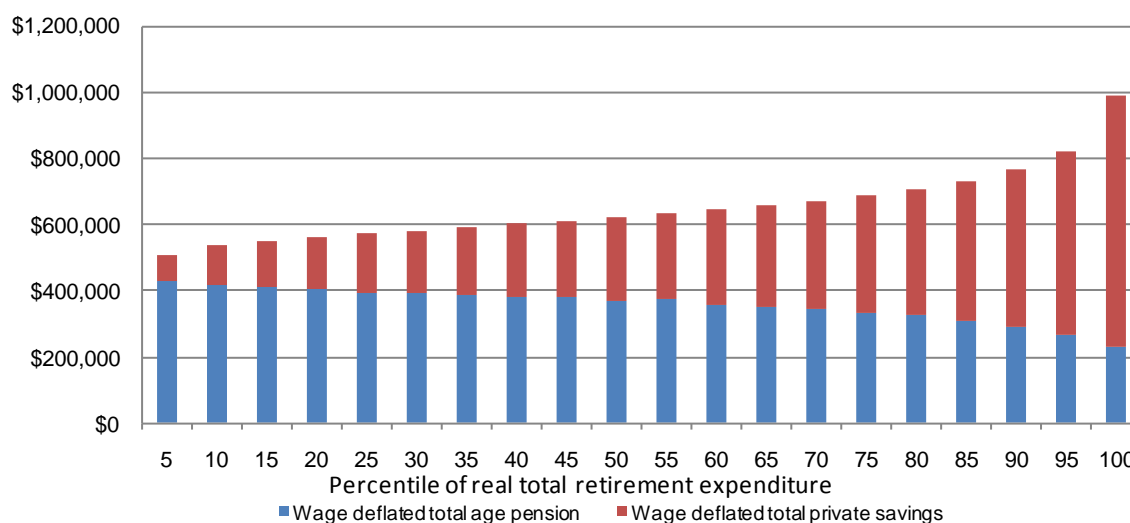
5. The ‘cushioning’ effect of the Age pension on private savings

Continuing to focus on the contribution of the Age pension to individual’s retirement outcomes, this section analyses how the means-tested Age pension ‘cushions’ disparities in the performance of private savings.

For the same single female cameo as above (with the SG rate increasing to 12 per cent), the 1000 stochastic runs are ranked according to total real retirement expenditure, where expenditure was deflated using wage growth from the run rather than price inflation. Wage deflation is used here to aid comparison between the different runs: the maximum value of the Age pension is linked to wage growth through its legislated average wages benchmark, and so can vary significantly between different runs, even after adjusting for price inflation. Using a wage deflator facilitates comparisons by effectively holding the maximum rate of Age pension constant across runs.

Chart F then shows how this total wage-deflated expenditure is split between private savings and Age pension for each vintile.

Chart F. Expenditure from Age pension and private savings, by percentile of real total retirement expenditure.



The significant contribution of the Age pension to total retirement expenditure is apparent, with runs in the centre of the distribution receiving around 60 per cent of their wage-deflated retirement expenditure through the Age pension.

Further, the considerable equalising effect of the Age pension is also apparent: runs at the 80th percentile of total retirement expenditure enjoy private savings drawdowns that are 2.4 times larger than runs at the 20th percentile. However, this disparity is significantly lessened once the Age pension is included in calculations. In this case, runs at the 80th percentile have total real retirement expenditure that is just 1.3 times greater than that of runs at the 20th percentile.

6. Discussion of portfolio allocation metrics

Portfolio allocation decisions are important for most Australians, as the nature of the Australian retirement income system involves individuals holding their own superannuation accounts, and so directly bearing significant investment risk. This is not the case in many European countries for example, where social security schemes pay out retirement benefits based on factors such as years of work and salary levels, rather than the performance of an investment portfolio.

This paper now turns from analysing the distribution of retirement outcomes given a particular exposure to growth assets, and explores how these distributions shift in response to simple portfolio allocation changes. Such investigations were a key driver of developments in stochastic modelling of investment performance, indeed, the parameterisation of the Wilkie framework employed here was originally used by Butt and Deng for precisely this purpose.

Analysis of different portfolio allocation strategies using stochastic models typically involves assessing outcomes against a particular metric. The primary focus of this section is a discussion of the merits of various metrics in the Australian context. One obvious metric is expected total retirement expenditure. However, this has weaknesses that will be discussed below. Butt and Deng, in the context of their work which incorporated longevity as well as investment risk, noted different possible metrics and focussed on expected years of ruin (the expected number of years of life after private savings has been exhausted). Similar metrics were used in Ho et al (1994).

Comparing portfolio allocation strategies on the basis of expected total retirement expenditure can lead to misleading conclusions if the mean outcome is skewed upwards because of a small number of very successful runs. This is particularly the case if little weight should be placed on extreme results from the stochastic model. In the Australian context, the presence of the Age pension can also contribute to an upwards bias. Even in runs when private savings are exhausted, significant (Age pension) expenditure is still possible, weakening the ability of these runs to offset other highly successful runs when calculating the mean.

This leads to consideration of ‘years of ruin’ type metrics, which do not suffer from this bias caused by a small number of very successful runs, and so can provide more information about the risks involved with particular strategies. However, such metrics often involve discarding information about how well runs that did not exhaust private savings performed. This was recognised by Butt and Deng, for example, in their discussion about how bequest motives might influence the appropriateness of the ‘years of ruin’ metric. Another concern in the Australian context turns on the presence of the Age pension – even in years where private savings are exhausted, the Age pension may supply an adequate level of income. In particular, this could be the case in later, more sedentary years of retirement, when discretionary spending pressures may well be lower (however, health care costs may be higher – further research on the topic of spending profiles over retirement is being undertaken by Higgins and Dewhurst (2009), for example).

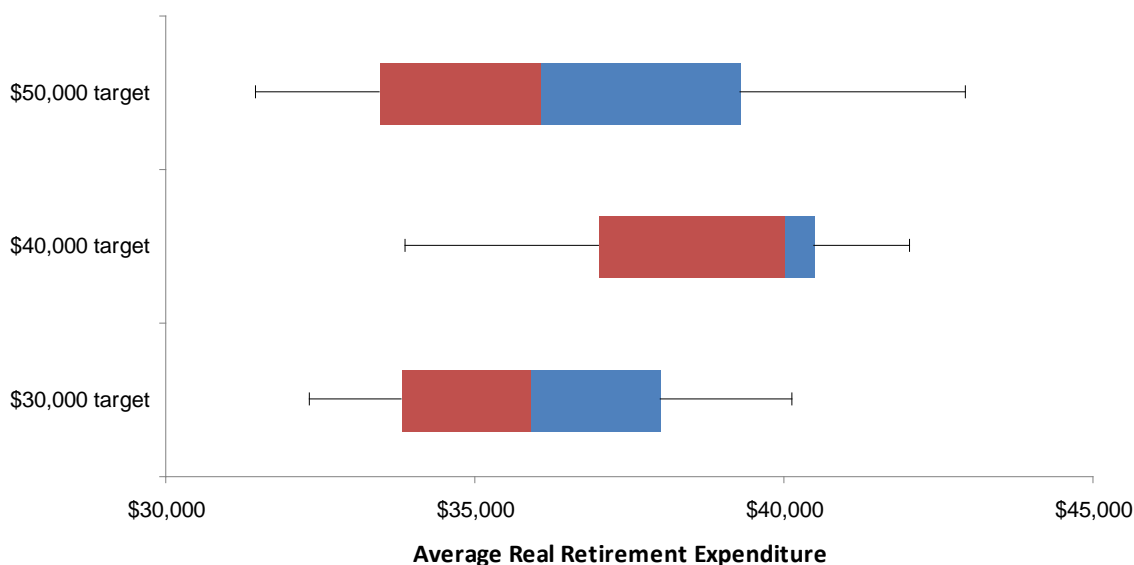
The performance of several of these metrics is explored using the Wilkie model linked to RIMHYPO, as described earlier in this paper. A simple cameo is used, based on a single homeowner retiring in 2010-11 aged 65, and with \$340,000 of savings in super. They place all their super in an allocated pension with a particular exposure to growth and defensive assets. As before, this portfolio is assumed to be rebalanced each year to maintain a constant exposure to risk. Again, longevity risk is ignored, with the person always dying at age 87.

Rather than the drawdown pattern used in the first part of this paper, in these cameos they draw down exactly enough to meet an (inflation indexed) expenditure target, including any Age pension they are eligible for (the increasing real value of the Age pension means that lower drawdowns are required in later years). This drawdown pattern is chosen as it is transparent when there is a shortfall in private savings. In some cases the drawdowns required to meet their expenditure target would violate the current legislative minimum drawdown limits, and so the minimum drawdown is used instead.

For these cameos an (inflation indexed) expenditure target of \$40,000 per annum is chosen. This is a sizeable sum, above the ‘Comfortably affluent’ Westpac-ASFA budget standard which is meant to deliver a lifestyle appropriate for those in the most affluent 20 per cent of retirees. Such a target is possible given the assumption of a large initial allocated pension balance. However, it should be clear that these stylistic cameos are not meant to be representative, but are merely to illustrate the discussion of possible metrics for assessing portfolio allocation strategies.

An expenditure target of \$40,000 was chosen as this tended to result in higher real average retirement expenditure than targets of either \$30,000 or \$50,000. Chart G illustrates this for the case of a 60 per cent exposure to growth assets.

Chart G. Percentiles of real average retirement expenditure, by expenditure target



Leftmost bar is at the 10th percentile of outcomes, red bar covers the region from the 25th to the 50th percentile, the blue bar covers the region from the 50th to the 75th percentile, and the rightmost bar extends to the 90th percentile of outcomes.

Note: Chart G results assume a 60 per cent exposure to growth assets – other exposure levels look similar.

From Chart G, it is clear that an expenditure target of \$30,000 does not optimise real average retirement expenditure for this scenario – the 10th percentile of runs with this target already has a real average retirement expenditure that is greater than \$30,000, thereby indicating that the legislated minimum drawdown was operational in some years, and so savings are likely to still be significant at the point of death. This in turn indicates that a higher level of expenditure could be expected to be maintained.

On the other hand, the runs with an expenditure target of \$50,000 fall well short of this target at the percentiles examined in Chart G. This indicates that the target was not able to be met in many years for many runs, pointing to the fact that this continuing high level of drawdowns is likely to exhaust private savings before death.

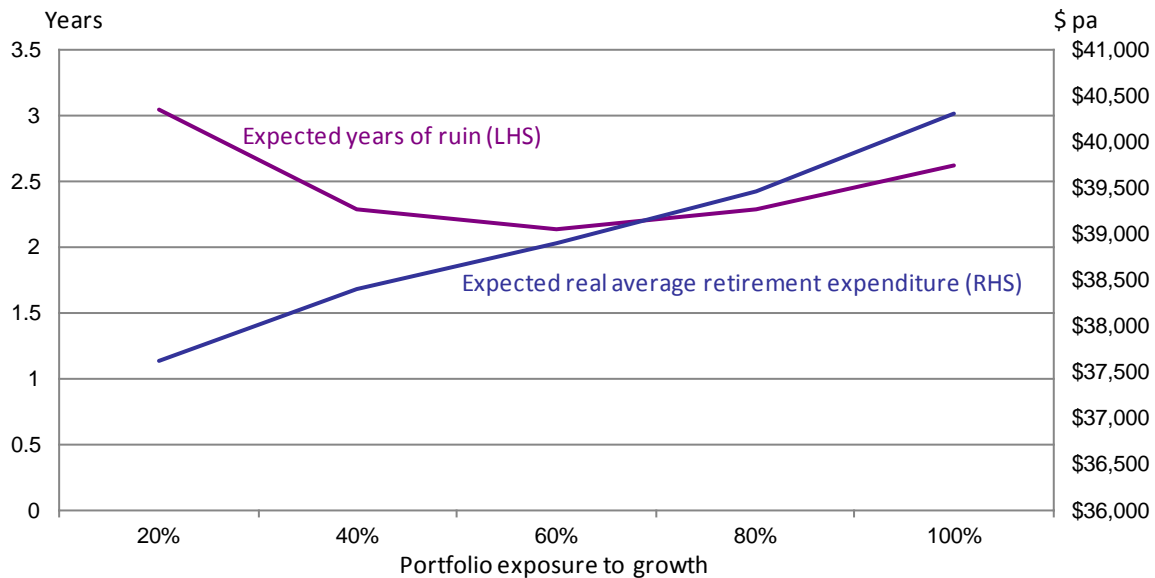
Chart G shows the runs with a \$40,000 expenditure target tended to outperform similar runs with the alternate targets (with the exception of runs at the 90th percentile – the 90th percentile of runs with a \$50,000 expenditure target have a higher real average retirement expenditure than the 90th percentile of runs with a \$40,000 target). The median run has an average real retirement expenditure of \$40,000, indicating that runs in the centre of the distribution can meet their expenditure target over their whole retirement.

Having selected a \$40,000 expenditure target to go with the assumption about the initial balance of the allocated pension, 1000 runs with this target were then run for each of five different levels of exposure to growth assets. Note that this is a considerable simplification of any realistic strategy – not only is the expenditure target not adjusted over the years with regard to the level of remaining assets, but the exposure to risk is also held constant regardless of outcomes so far. It is hard to see an optimal portfolio allocation and drawdown strategy not making any use of actual outcomes to guide settings in future years. However, such a simplification is useful when the goal is not to find an optimal strategy but to explore the merits of different metrics for choosing between strategies. Also, there is an element of circularity in deciding on an expenditure target using a particular portfolio allocation, and then for this chosen target finding an optimal portfolio allocation. In this

case such a concern is reduced, however, as the \$40,000 expenditure target outperformed the alternatives at all levels of exposure to growth, with the exception of the top quartile of runs with 80 per cent or higher exposure to growth.

Chart H plots the expected years of ruin and real average retirement expenditure for each of the different levels of exposure to growth assets.

Chart H. Expected years of ruin and real average retirement expenditure for \$40,000 expenditure target, by exposure to growth assets.



Expected years of ruin are high at low levels of exposure to growth assets, reflecting the inability of largely defensive portfolios in the model to sustain the drawdowns required to meet the expenditure target (\$40,000 in real terms). At high levels of exposure to growth assets, the expected years of ruin are also relatively high, reflecting the modelled likelihood of such portfolios suffering adverse returns which cannot be recovered from while also continuing to meet the expenditure target. According to this metric, an optimal allocation would include around 60 per cent exposure to growth assets.

Modelled expected real average retirement expenditure increases with the portfolio's exposure to growth. In particular, when 100 per cent of the portfolio is allocated to growth assets, the mean across the 1000 model runs' real average retirement expenditure is actually *above* the expenditure target of \$40,000, reflecting some runs being forced by the minimum drawdown limits to exceed the drawdown required to meet the target. These cases are therefore enjoying a significant asset base in these years. Overall, according to the current model, using expected real average retirement as a metric would result in choosing a portfolio consisting entirely of growth assets.

Comparing the two metrics provides insights into the relative strengths of each. Using expected years of ruin places emphasis on downside risks (even if 'ruin' might be too strong a term to describe years when a person is reliant on the Age pension). However, it is hard to distinguish runs that do very well, as any run that does not exhaust private savings receives the same score on the metric. On the other hand, very successful runs do influence the value of expected real average retirement expenditure. In this case, however, such runs are so influential they tend to obscure the runs that feature poor private savings performance. Partly this is because poor private savings

performance is lessened by significant Age pension receipt, which reduces the ability of these runs to offset highly successful runs.

From the discussion above, it is apparent that the choice of metric should depend on the user's appetite for risk. Chart I provides more detailed distributional outcomes for the different allocation strategies that were modelled.

Chart I. Real average retirement expenditure by portfolio exposure to growth assets and percentile of outcome, for a \$40,000 expenditure target.



Leftmost bar is at the 10th percentile of outcomes, red bar covers the region from the 25th to the 50th percentile, the green bar covers the region from the 50th to the 75th percentile, and the rightmost bar extends to the 90th percentile of outcomes.

People who place a high value on avoiding being left without private savings would employ a strategy that maximised expenditure for runs among the lower percentiles – for example, in this modelling the 10th percentile of runs with a 40 per cent exposure to growth outperforms the 10th percentile of runs for any other allocation. People who are more comfortable to engage with risk in the pursuit of higher retirement expenditure (or perhaps place more value on bequests) might instead employ a strategy that maximised expenditure at higher percentiles. Apart from the 20 per cent exposure to growth portfolio, the median runs of all the strategies modelled here were able to sustain their expenditure target over the whole of retirement. Thus a person wishing to base their decision on median performance would have to use more information to distinguish the different strategies, for example the expected size of any bequests (which tend to rise with exposure to growth assets).

7. Conclusion

Stochastic modelling of economic conditions extends the range of analysis that can be undertaken by hypothetical models. This paper presents the results of linking Butt and Deng's parameterisation of a Wilkie-type stochastic model of key economic series to Treasury's hypothetical model of retirement outcomes, RIMHYPO. The effect of the announced increase in the SG rate was investigated using this linked model, and also the cushioning effect of the Age pension on variations in the performance of private savings. Finally, different metrics for assessing the performance of portfolio allocation strategies were discussed.

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APPENDIX A – TAKEN FROM BUTT & DENG, 2010

Wilkie model equations

Variable	Notation	Equation
Price Inflation	$q(t)$	$q(t) = \mu_q(1 - \phi_q) + \phi_q q(t-1) + \varepsilon_q(t)$
Salary Inflation	$w(t)$	$w(t) = \psi_{w,2} q(t-1) + \mu_w + \varepsilon_w(t)$
Short-Term Interest Rate	$is(t)$	$\ln[is(t)] = \ln[il(t)] - X_{is}(t)$ $X_{is}(t) = \mu_{is}(1 - \phi_{is}) + \phi_{is} X_{is}(t-1) + \varepsilon_{is}(t)$
Cash	$ac(t)$	$ac(t) = (is(t) + is(t-1)) / 2$
Long-Term Interest Rate*	$il(t)$	$il(t) = \psi_{il} M_{il}(t) + \mu_{il} + X_{il}(t)$ $M_{il}(t) = \rho_{il} q(t) + (1 - \rho_{il}) M_{il}(t-1)$ $X_{il}(t) = \phi_{il,1} X_{il}(t-1) + \phi_{il,2} X_{il}(t-2) + \phi_{il,3} X_{il}(t-3) + \varepsilon_{il}(t)$
Australian Equity Dividend Yield	$y(t)$	$\ln[y(t)] = \ln \mu_y + X_y(t)$ $X_y(t) = \phi_y X_y(t-1) + \varepsilon_y(t)$
Australian Equity Dividends	$d(t)$	$d(t) = q(t) + \mu_d + \tau_{d,1} \varepsilon_y(t) + \tau_{d,2} \varepsilon_y(t-1) + \varepsilon_d(t) + \theta_d \varepsilon_d(t-1)$
Australian Equities Price Return [^]	$p(t)$	$p(t) = \ln(D(t) / \ln(1 + y(t))) - \ln(P(t-1))$
Australian Equities Total Return	$ae(t)$	$ae(t) = p(t) + \ln \left(\frac{1 + \ln(1 + y(t))}{\times (\exp(p(t)))^{0.5}} \right)$
International Equities (Total Return)	$ie(t)$	$ie(t) = \mu_{ie} + \psi_{ie} ae(t) + \varepsilon_{ie}(t)$
Australian Bonds (Total Return)	$ab(t)$	$ab(t) = \psi_{ab,1} il(t) + \psi_{ab,2} il(t-1) + \psi_{ab,3} is(t) + \psi_{ab,4} is(t-1) + \varepsilon_{ab}(t)$
International Bonds (Total Return)	$ib(t)$	$ib(t) = \mu_{ib} + \psi_{ib} ab(t) + \tau_{ib} \varepsilon_q(t) + \varepsilon_{ib}(t)$

* constrained to a minimum of 0.001.

[^]Capital forms of small notation (e.g. $D(t) = D(t-1) \exp(d(t))$) refers to the index value of that variable.

Wilkie model – standard error of residuals (SERes), fitted parameter values and standard errors

Notation	SERes	Parameter	Fitted Value	Standard Error
$q(t)$	0.0164	μ_q	0.0349	0.0104
		ϕ_q	0.7218	0.1276
$w(t)$	0.0142	$\psi_{w,2}$	0.5407	0.1068
		μ_w	0.0228	0.0051
$is(t)$	0.1939	μ_{is}	0.0937	0.0644
		ϕ_{is}	0.4324	0.1900
$il(t)$	0.0057	ψ_{il}	1.2268	0.0032
		μ_{il}	0.0221	0.0595
		ρ_{il}	0.1720	N/A ¹
		$\phi_{il,1}$	0.1105	0.1859
		$\phi_{il,2}$	-0.2994	0.1641
		$\phi_{il,3}$	-0.3369	0.1620
$y(t)$	0.1654	$\ln \mu_y$	-3.2457	0.0610
		ϕ_y	0.4900	0.1774
$d(t)$	0.0925	μ_d	0.0401	0.0269
		$\tau_{d,1}$	0.3801	0.1195
		$\tau_{d,2}$	-0.2601	0.1236
		θ_d	0.5014	0.1664
$ie(t)$	0.1378	μ_{ie}	0.0074	N/A ²
		ψ_{ie}	0.9341	0.1860
$ab(t)$	0.0075	$\psi_{ab,1}$	-3.5495	0.2248
		$\psi_{ab,2}$	4.4186	0.2047
		$\psi_{ab,3}$	-0.2434	0.1139
		$\psi_{ab,4}$	0.3789	0.1152
$ib(t)$	0.0297	μ_{ib}	0.0225	N/A
		ψ_{ib}	0.7788	0.1175
		τ_{ib}	1.2243	0.4134

1. Due to the nature of the long-term interest rate equation it is not possible to create a linear model to find the value of ρ_{il} which minimises the squared error in the model. As such a range of values was tested to find the minimum value standard error of residuals, with $\rho_{il}=0.172$ selected (to two significant figures).

2. The values of μ_{ie} and μ_{ib} are set to ensure the expected returns under Australian and international investment are consistent.