

Sequencing Risk: The Worst Returns in their Worst Order

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Published

2013

Journal Title

JASSA

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SEQUENCING RISK: *The worst returns in their worst order*^{1,2}

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For the first of the baby boomers turning 65 years of age, after a decade littered with financial shocks (dot.com bubble, sub-prime, global financial crisis, sovereign debt), sequencing risk can represent a significant threat to their retirement nest eggs. This paper takes an outcome-oriented approach to the problem, to provide practical insights into how sequencing risk works and the critical dependency of retirement outcomes on sequencing risk. Our analysis challenges the conventional wisdom that it is the accumulated average of investment returns that matter. We show, instead, that it is the realised sequence of returns which largely determines the sustainability of retirement incomes.

The road to achieving a sustainable level of retirement income can be long and winding. An event such as the global financial crisis (GFC) impacts all investors; however, it does not necessarily affect everyone equally. For some, such as those who are near retirement (or have recently retired), the dollar-weighted impact of a GFC-like event on their retirement nest egg can be much larger than that for younger generations.

The term 'sequencing risk' is used in the world of finance to denote the impact of a large loss close to or just after retirement when the largest dollar balance is present in the portfolio. We define sequencing risk as the risk of experiencing returns in an unfavourable order. The risk is omnipresent in a portfolio which will experience multiple contributions and/or withdrawals (such as the cash flow profile of saving for retirement and subsequently drawing on these holdings to provide retirement income). The famous English poet, Samuel Taylor Coleridge, once described poetry as 'the best words in their best order'. We admire the economy of words in this phrase and have adapted it to our work on sequencing risk, and frame the risk as 'the worst returns in their worst order'.

This study considers the Australian superannuation setting where around 80 per cent of all pension assets in Australia are held by defined contribution (DC) plans to consider the potential impact of sequencing risk on retirement outcomes.

The plan member and summary statistics

Understanding how sequencing risk can potentially impact retirement savings is best illustrated by

example. We take a hypothetical plan member who commences work at the age of 24 on 1 January 2012, and works for 41 years to retire at the age of 65. A summary is provided in Table 1; it is this contribution profile that is employed throughout the study.³

TABLE 1: Key assumptions

Variable	
Starting balance	\$0
Starting salary	\$41,552*
Salary growth rate	4% p.a.
Contribution rate	9% p.a.
Starting age	25 years**
Retirement age	65 years
Cumulative contributions	\$373,319***

* Average MyCareer starting salary for all sectors as at end-April 2012.

** First contribution made at end of first year (i.e. 1 January 2013), final at end of year (i.e. 1 January 2053)

*** This is the total value of all contributions over 41 years.

While these key assumptions provide the contribution profile of our hypothetical investor, the study also requires return paths and, for this, we use history as a guide. We use nominal annual returns from the updated version of, Dimson et al. (2002) dataset, which is commercially available through Morningstar. Our sample is comprised of 112 years of annual returns (from 1900 to 2011) for Australian and US equities, bonds and cash.⁴ We conduct a rolling analysis with the data, providing a string of 40-year investment cycles beginning with 1900-1939 and ending with 1972-2011 to arrive at a total of 73 rolling 40-year investment paths. The final piece of the puzzle is deriving an asset allocation strategy for the member.

The study uses a typical balanced (or, target risk) fund, rebalanced annually (66 per cent growth; 34 per cent defensive). We derive the asset allocation design from the *Annual Superannuation Bulletin* released by the Australian Prudential and Regulation Authority (APRA) in 2012. The average default investment strategy in Australia as at 30 June 2011 had eight asset classes with one classified as 'other'. The data we use is limited to six asset classes back to 1900 and, hence, we have a trade-off of long-run analysis to granularity in the mix of assets.⁵ In the literature the common approach to dealing with this is to create proxies for the assets which are not covered by the data (Basu and Drew 2009a; Basu et al. 2011). These proxies are outlined in Table 2 and the long-run 1900–2011 summary statistics of the derived asset allocation are provided in Table 3.

TABLE 2: Asset allocation of the default strategy

Asset class	Australian default	Study's default
Australian shares	29%	36%
International shares	24%	30%
Listed property	3%	-
Unlisted property	7%	-
Australian fixed interest	10%	16%
International fixed interest	6%	10%
Cash	8%	8%
Other assets	13%	-

Notes to asset allocation design:

1. Other assets is split into Australian and international shares at 7 per cent, respectively.
2. Listed and unlisted property are assumed to follow traits similar to fixed interest. The ratio of Australian to international is used to place 6 per cent of the combined 10 per cent in Australian and the remaining 4 per cent in international.
3. International fixed interest and international shares both use the US as a proxy.

TABLE 3: Summary statistics for the returns of the default asset allocation strategy (1900–2011)

Variable	Summary statistic
Mean	10%
Standard deviation	11%
Skewness	0.08
Kurtosis	3.38

How sequencing risk impacts DC plan members

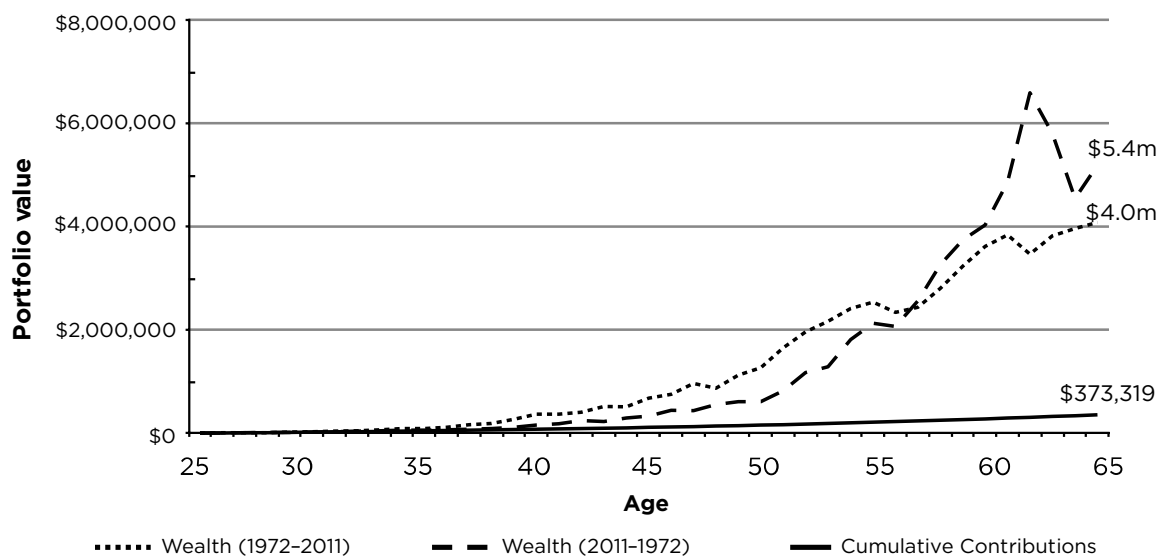
With our cash flow and asset allocation profile established, we can start to draw some preliminary insights into how sequencing risk can impact retirement outcomes in a defined contribution plan. Illustrating a practical example of our definition that sequencing risk is an unfavourable order of returns, we show what a change in the ordering means to the outcome. Figure 1 below illustrates two possible paths for our member; the most recent 40-year path from 1972–2011 and the reversed order of returns (that is, 2011–1972).

When employing the outlined assumptions of this study, the actual historical path reaches a final outcome of \$4 million, while the reversed order reaches \$5.4 million, a 35 per cent increase in terminal wealth. The accumulation paths in Figure 1 use identical distributions i.e. the four moments of the distribution for both series are identical, however, the order in which they are experienced is reversed. Figure 1 highlights the importance of the order of returns to investors' terminal wealth outcomes, a finding which corroborates that of Doran et al. (2012).

Historical outcomes

The dispersion of terminal wealth outcomes emphasises the point that returns are a crucial factor to the outcome. All of the paths are subject to the

FIGURE 1: Wealth accumulation paths for two return paths: (1972–2011) and the reverse (2011–1972)



same underlying assumptions around contributions yet the dispersion, as seen in Table 4, has a range of almost \$5.4 million. The minimum balance of \$1.4 million is around seven times the level of the final salary while the maximum, \$6.7 million, is almost 34 times the final salary.⁶ The variations in terminal wealth outcomes are driven by the returns in these paths: both the underlying compounded return, and the order in which they are experienced. Further investigation in the subsequent sections of this study can help disentangle the two.

TABLE 4: Summary statistics for the dispersion of terminal wealth outcomes

Statistic	Result
Median	\$2.9m
Minimum	\$1.4m
Maximum	\$6.7m
Range	\$5.4m
25th percentile	\$2.5m
75th percentile	\$4.4m
Mean	\$3.4m
Standard deviation	\$1.4m
Skewness	0.83
Kurtosis	2.60

Note: Numbers in the table are rounded and should be used as a guide only.

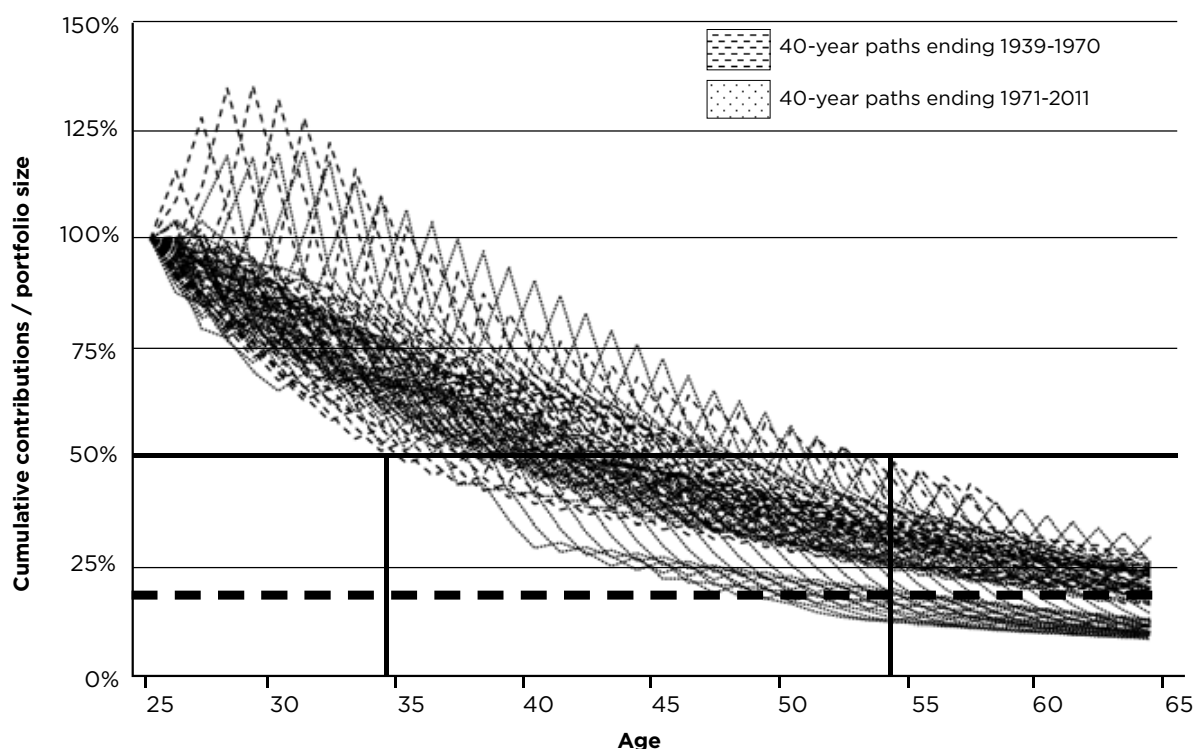
Total cumulative contributions for all of the paths represented in this paper are \$373,319. A careful analysis of Figure 1 and Table 4 reveals that the

cumulative contributions by the time of retirement are a fraction of the total portfolio value. Taking this further, we also observe the relationship between the portfolio size and the cumulative contributions over the life course. Figure 2 illustrates the cumulative contributions divided by the total portfolio value over the accumulation period. Figure 2 below tracks all of the 73 accumulation paths over the 40-year periods. The accumulation paths are segregated into two groups: (i) paths ending between 1939 and 1970 (both years inclusive); and (ii) paths ending between 1971 and 2011 (both years inclusive).

Figure 2 highlights the point at which the 50 per cent contribution-to-total portfolio size point is reached (solid black line intersecting 50 per cent on vertical axis). For all of the 40-year accumulation paths from 1900 to 2011, the range of outcomes is between 34 and 54 years of age (the 9th and 29th years of accumulation, respectively). It can be seen that, beyond this point, investment returns account for an increasingly large proportion of the portfolio balance; conforming to the portfolio size effect findings of Basu and Drew (2009a) and Basu et al. (2011).

While acknowledging the distribution of particular outcomes, one observation from Figure 2 is that in the final years of the accumulation phase (say, the last 10 from age 56), a rule of thumb can be applied such that contributions only account for about, on average, one-fifth (or 20 per cent, identified by the dashed line intersecting the vertical axis at 20 per cent) of the total portfolio balance.⁷

FIGURE 2: Total cumulative contributions as a percentage of total portfolio balance for all 40-year accumulation paths from 1900 to 2011 using the default strategy's annual returns (n=73)



The finding suggests that even muted levels of bad volatility, occurring at the worst time, can have a significant impact on members' retirement savings. Indeed, it is not necessarily the magnitude of the negative return that matters, but its timing.

The findings suggest that there is something similar to the Pareto principle⁸ ('the vital few and trivial many') at play with sequencing risk; i.e. late in the accumulation phase around 80 per cent of the member's final balance is attributable to returns, and 20 per cent to contributions.⁹ This provides further nuance to our understanding of sequencing risk, the worst returns in their worst order. The finding suggests that even muted levels of bad volatility, occurring at the worst time, can have a significant impact on members' retirement savings. Indeed, it is not necessarily the magnitude of the negative return that matters, but its timing.

While the distribution of outcomes in Table 4 and Figure 2 can be related to sequencing risk, we cannot reject the possibility that the underlying compounded return also contributes to it. To examine this issue, we look at two historical return paths which result in similar terminal wealth outcomes. The 40-year paths ending in 1942 and 1978 produce identical terminal wealth outcomes of \$1.9 million each for the member. However, when we look at the respective arithmetic and geometric returns of these paths, a different picture emerges. Table 5 illustrates these figures.

TABLE 5: Arithmetic and geometric returns for 40-year accumulation paths ending 1942 and 1978

Variable	1942	1978
Arithmetic return per annum	8.69%	9.04%
Geometric return per annum	8.36%	8.96%
Terminal wealth	\$1.9m	\$1.9m

While the annual rates of return experienced by each path are quite different, the final balances (that is, the total retirement nest eggs) are essentially the same. The 40-year accumulation path ending in 1978 has an arithmetic (geometric) return 71 (33) basis points per annum or 8.17 (3.95) per cent per annum greater than the 1942 path, yet the terminal wealth outcome is virtually identical (the final account balance of the lower return path, 1942, is higher than the 1978 final account balance by around \$500). Sequencing risk is the key reason that the two accumulation paths converge to the same terminal wealth values. These findings are consistent with Milevsky and Abaimova (2008) and Neuman (2011) who conjectured that the sequence is at least as important as the underlying rate of return.

How bad can it get?

So far we have illustrated that the order of returns is a crucial component to the terminal wealth outcome for members. However, the fundamental question on sequencing risk still remains — how bad can it get? To answer this question, we employ an empirical bootstrap technique used by Dichev (2007), Dichev and Yu (2011) and Dvorak (2012).¹⁰ For each of the 73 different 40-year periods within our sample period, we resample returns without replacement to construct simulated 40-year investment horizons representing a reordered sequence of historical returns. We repeat this procedure 10,000 times.

The above bootstrap simulation results in an output consisting of 730,000 terminal wealth outcomes. Essentially, we are massaging the data in Figure 1 (which was an example of one shuffle-reversed order), shuffling this data 10,000 times to understand the distribution of possible outcomes. We sort these terminal wealth outcomes and provide a nonparametric illustration of key percentiles on a rolling 40-year basis in Figure 3. The actual terminal outcomes are illustrated by the thick black line, while the median is represented by the white line.^{11, 12}

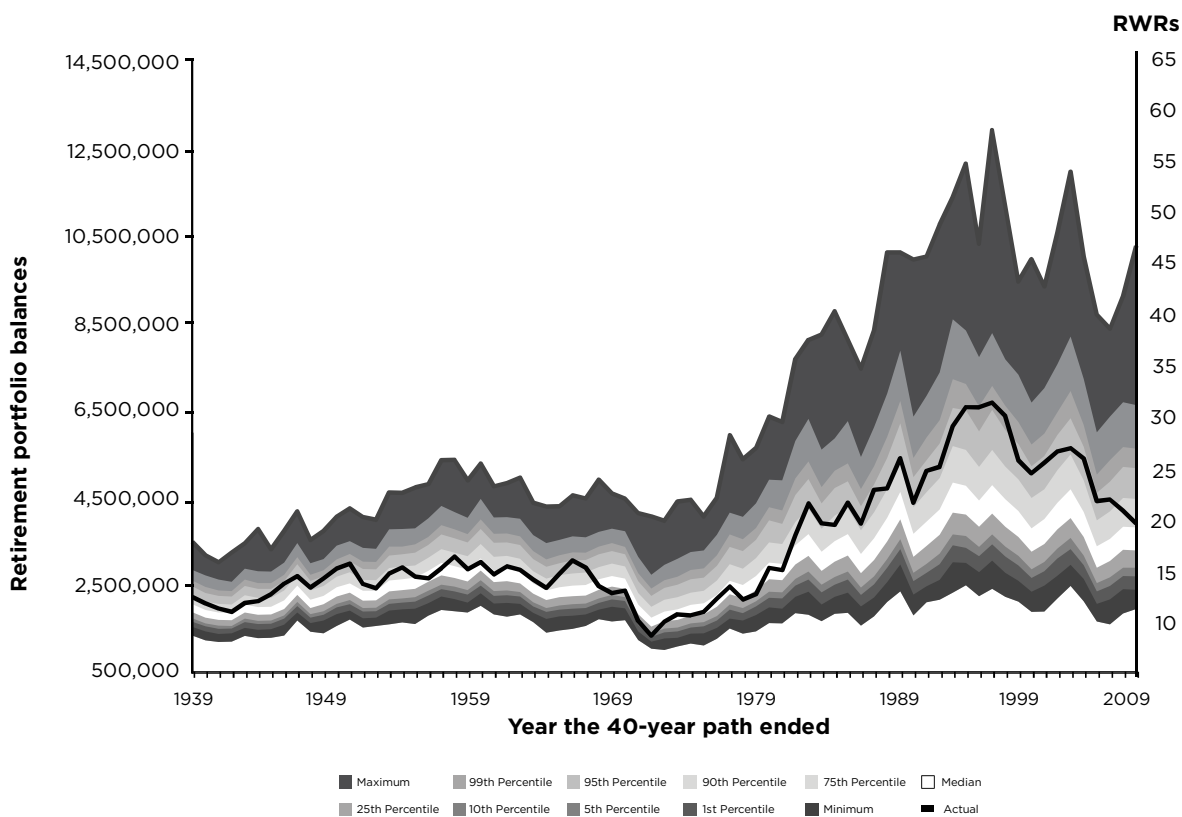
The most important point to note in Figure 3 is that for every cross-sectional point on the horizontal axis, the range of outcomes is entirely dependent on sequencing risk and not the rate of return; or any of the higher moments. The distributions of outcomes in Figure 3 have ranges well into the millions. Combining this range with the knowledge of total cumulative contributions representing \$373,319, it is daunting to realise multiples of your total cumulative contributions can be added or subtracted from your balance solely by sequencing risk.

While the actual outcome in Figure 3 tends to track close to the median, it does have points at which the 7th and 92nd percentiles are achieved in the paths ending 1974 and 2000, respectively. These extremes highlight that the range of potential outcomes in Figure 3 are both plausible and realistic for members. This finding reiterates the importance of having the sequence of returns as an important consideration in the retirement income adequacy debate.

Concluding comments

Conventional wisdom suggests that, given a certain level of contributions, retirement wealth depends on the number of good and bad return periods experienced over a lifetime and the magnitude of those good and bad returns. In this paper, we have demonstrated that the retirement wealth of long-term investors with multiple cash flows is not only affected by the frequency and magnitude of good and bad returns, but also by the sequence in which those returns occur. Multi-period investors with identical average returns and volatilities over

FIGURE 3: The default strategy's annual returns are used to determine every 40-year accumulation path from 1900 to 2011. (These were reshuffled via a bootstrap method 10,000 times each to simulate 10,000 final portfolio balances; assumptions about wealth creation are illustrated in Table 1.)



their lifetime will confront vastly different retirement wealth outcomes if the periodic returns are experienced in different orders or sequences.

The findings in this paper suggest that the ordered vector of returns is a critical component to the underlying terminal wealth outcome. The literature shows that there are two possible ways of diluting the impact of sequencing risk: adopting a strategy that either reduces the portfolio size effect (by spreading dollar-weighted allocations more evenly over one's investment life) or taking a whole-of-life approach to DC plan design (Ayres and Nalebuff 2010; Basu et al. 2011). Going back to Coleridge's poetry analogy, investment markets do not afford the luxury of rearranging and reordering returns to find the perfect sequence.¹³ However, there is an opportunity to enhance retirement outcomes in DC plans through better understanding the uniqueness of the plans of individual members.¹⁴

To improve retirement outcomes for members there is a need to ensure that the conversation about the management of sequencing risk, which often occurs during the critical retirement conversion phase, is brought forward to be at the heart of DC plan design and governance. Particularly during the critical conversion phase (popularly termed the 'retirement

risk zone') say, the final 15 years of the accumulation period and the first decade of the distribution phase, many investors are unaware that it is not the average return of their investments, but the realised sequence of those returns that can largely determine the sustainability of their retirement income. With increasing numbers of baby boomers entering this phase, the sequence of returns risk is a current and significant challenge. ■

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Notes

1. This paper is an adaptation of an industry report, *Sequencing risk: A key challenge to sustainable retirement income*, published by Finsia in October 2012 (Basu et al., 2012) and is available online from <http://www.finsia.com/docs/policy-research/sequencingrisk-a-key-challenge-to-creating-sustainable-retirement-income.pdf?sfvrsn=0>.
2. This research was supported by a Finsia Research Grant: 'How important is the order of returns? The impact of sequencing risk on retirement wealth outcomes in Australia' administered by Griffith University. We acknowledge and thank Finsia for their support, particularly Russell Thomas (CEO), Angie Corkhill (Director, Member Relations and Policy), Samuel Bell (Manager, Policy), Deidre Grover (Senior Policy Advisor) and members of the Finsia Policy Advisory Council (30 May 2012, Sydney) and Finsia Managed Funds and Superannuation Advisory Group (20 June 2012, Melbourne). We also thank Robert Bianchi, Graham Bornholt, Peter Doran, Evan Reedman, Eduardo Roca, Troy Rieck, Adam Walk SF Fin and participants at the Griffith University NRIP (Superannuation and Funds Management) Seminar on 'Sequencing risk: the worst returns in their worst order' (4 June 2012, Brisbane) for comments and discussion. We thank Prof Kevin Davis (Managing Editor, JASSA) and the helpful comments from an anonymous reviewer. Of course, any remaining errors are our responsibility. The views expressed herein are those of the authors and are not necessarily those of Finsia.
3. There is a myriad of contribution profiles and wage growth profiles which can be employed, such as gender and unemployment impacts (Merton, 1969; Davis 2007; Basu and Drew 2009b), however, we leave this to future research. We employ a simple 4 per cent per annum, which is made up of real wage growth and inflation (Byrne et al. 2006; Basu and Drew 2009a; Basu et al 2011). We also acknowledge the importance of contribution tax and contribution caps on superannuation outcomes. However, we have excluded taxes from our model to focus exclusively on the issue of sequencing risk, which is prevalent in the presence or absence of taxes. Our motivation is to provide baseline findings in the Australian setting that can be used by future researchers to advance the sequencing risk debate.
4. Nominal returns are used in the study and are common in the literature (Guo and Darnell 2005; Basu and Drew 2009a; Basu et al 2011). The results are also consistent in a confirmatory analysis with real returns in the appendix of the larger report published by Finsia, *Sequencing risk: A key challenge to sustainable retirement income*, (Basu et al. 2012).
5. The six asset classes being Australian and US equities, bonds and cash. We limit this to only five in our portfolio and remove international cash holdings (i.e. US cash) as this is not specifically listed in the APRA document.
6. Final salary is \$199,495.
7. This rule of thumb is supported by the inflation-adjusted analysis presented in the full report, *Sequencing risk: A key challenge to sustainable retirement income*, (Basu et al. 2012), in which we use a 40 per cent (contributions), 60 per cent (returns) general rule.
8. The term 'the Pareto principle' and the associated quote 'the vital few and the trivial many' have been attributed to Joseph M Juran (1904–2008) based on the work of Vilfredo Pareto. For a discussion see: www.juran.com/index.html
9. The mean (contribution/portfolio balance) 10 years from retirement for all 40-year accumulation paths is 21 per cent while the minimum and maximum are 8 per cent and 44 per cent, respectively.
10. This allows for the four moments to be held constant in simulation, which allows us to target the impact of sequencing risk better as opposed to Frank and Blanchett (2010) who conduct a Monte-Carlo simulation which equalises the mean and standard deviation of returns without controlling for skewness and kurtosis.

11. Figure 3 is produced in a colour version in the full report; this is available through Finsia in the full report, *Sequencing risk: A key challenge to sustainable retirement income*, (Basu et al. 2012). See also <http://www.finsia.com/docs/policy-research/sequencingrisk-a-key-challenge-to-creating-sustainable-retirement-income.pdf?sfvrsn=0>
12. Retirement wealth ratios (RWRs) are also depicted in Figure 3. These illustrate what multiple of final salary the terminal wealth value has achieved (Basu and Drew 2009a, 2010; Antolin et al. 2010).
13. The challenges that sequencing risk may pose for public policy are formally acknowledged, particularly for the provision of the public pension. Potentially, sequencing risk fragments outcomes for members of DC plans and, as a result, this is problematic in terms of policy outcomes. It is submitted that this line of investigation is important and future researchers are encouraged to consider sequencing risk more formally through the lens of public finance. The importance of sequencing risk for self-managed superannuation funds (SMSFs) is also noted and this issue is left for future researchers.
14. Potentially, sequencing risk is not only borne by an individual. The problem for public policy arises when it is not just one individual who suffers a large loss on their retirement savings, but an entire cohort that endures the same loss. This is a realistic scenario with around 80 per cent of all Australians being enrolled in the default option and thus experiencing similar return paths with only minor differences between fund default strategies (Towers Watson 2012).