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# The Retirement Risk Zone: A Baseline Study

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**Abstract**

The retirement risk zone is commonly defined as the final decade of working life and the first decade of retirement. This paper undertakes a baseline study to explore the heady mix of the portfolio size effect (when the bulk of retirement savings are in play) and sequencing risk (the timing of a nasty market event) facing superannuants within this zone. The baseline approach adopted in this paper explores one idea, specifically, the impact on retirement outcomes when portfolios are subjected to a single sequencing risk event at different points through the members' investing life. We report sensitivities between the timing (or sequence) of a negative return event on terminal wealth outcomes and associated impact on longevity risk. Finally, we find an asymmetry in the impact of sequencing risk across the pre-and post retirement phases, suggesting that great priority needs to be given to the issue of sequencing risk earlier in the members' accumulation phase (say, 15 to 20 years prior to retirement) than convention suggests.

**Keywords:** Retirement risk zone, Sequencing risk, Longevity risk.

**JEL classification:** G11, G23.

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## Introduction

Are you closing in on retirement? Or have you recently retired? If so, you have lived through a decade littered with extraordinary periods of investment risk: the dotcom bubble; sub-prime lending; the GFC; and now, for your trouble, the sovereign debt crisis. You know better than others that investing for retirement is about taking risks. As investors, we are constantly walking a tightrope of taking a prudent amount of risk at every stage of our working and retirement lives. Too little risk and we will fall short of the promise of endless summers; too much risk can deplete our retirement nest-egg to the point we may never recover.

The retirement risk zone (also known as the 'conversion' phase) is commonly defined as the final 10 years of working life (the 'accumulation' phase) and the first 10 years of retirement (the 'decumulation' phase). Importantly, it is this 20 year period when the greatest amount of retirement savings is in play and, subsequently, risk is at its zenith.

Given the volatility experienced over the last decade, how can we manage the risks that we face in the critical conversion phase (or retirement risk zone) of our investing life? The impact of these risks were never more evident than during the GFC, when people near or at retirement felt the full extent of two related forces: the portfolio size effect (what you do when the largest amount of your money is at risk matters); and the problem of sequencing risk (how much you lose during a bear market may not be anywhere near as important as the timing of the loss, again, especially during the conversion phase).

Let's explore these two concepts a little further. Recent research by Basu & Drew (2009) has drawn attention to one particular feature of the dynamics of retirement investing: the portfolio size effect. Basu & Drew (2009) find that, due to the positive compounding effect of salary growth, contributions and returns, portfolio size grows rapidly in the latter half of the accumulation phase. In terms of funding an adequate retirement income, a large and rapidly growing portfolio size is exactly what superannuation fund members seek to achieve. However, when the portfolio size effect is combined with an unfavourable sequence of returns ('sequencing risk' as in Macqueen and Milevsky, 2009), the goal of attaining our retirement objectives is jeopardised. Today, investors with a growth-oriented asset allocation aged in their late 50s/early 60s have borne the brunt of a decade of various financial crises –

these are clear and present examples of sequencing risk events that have impacted their retirement nest-egg and thus the sustainability of their retirement income.

Issues of the portfolio size effect and sequencing risk have a direct relationship to longevity risk. As we know, longevity risk is the likelihood that superannuation savings will be depleted prior to satisfying the lifetime financial needs of the dependents of those savings (Macqueen and Milevsky, 2009). One way longevity risk manifests itself is when an investor's superannuation savings is subject to a major negative market event within the retirement risk zone. A smaller pool of retirement savings will, *ceteris paribus*, deplete at a faster rate than a larger pool, hence retirement outcomes are largely path dependent.

The combination of the portfolio size effect, sequencing risk, and longevity risk combine to form a trinity of investment issues that need to be managed by superannuants, particularly when inside the retirement risk zone. This paper undertakes a baseline study to explore just how dangerous these three related issues can be[1]. The baseline approach adopted explores one idea, specifically, the impact on retirement outcomes when portfolios are subjected to a single sequencing risk event at different points through their life course.

Using a bootstrap simulation approach, the paper finds that the sequence of returns materially impacts the terminal wealth of superannuants and heightens the probability of portfolio ruin. This paper finds that sequencing risk can deplete terminal wealth by almost a quarter, at the same time increasing the probability of portfolio ruin at age 85 from a probability of one-in-three, to one-in-two. It is our conjecture that, for someone in their 20s, the impact of sequencing risk is minimal: younger investors have small account balances, and plenty of time to recover (Bodie, Merton and Samuelson, 1992). However, for someone in their late 50s/early 60s, the interplay between portfolio size and sequencing risk can cause a potentially catastrophic financial loss that has serious consequences for individuals, families and broader society.

## Data and Method

[1] For completeness, we conceptualise a 'baseline study' as an "*analysis of current situation to identify the starting points for a program or project*", see http://www.businessdictionary.com/definition/baseline-study.html#ixzz1jkyV8j2E

This paper examines the impact of sequencing risk on a hypothetical investment portfolio with a constant asset allocation (rebalanced annually) as follows: 70% Australian equities, 20% Australian bonds and 10% Australian cash. Over a century of annual returns for these respective asset classes (1900 through 2009) were used[2]. Since the dataset spans several decades, we are able to capture the wide-ranging effects of favourable and unfavourable events of history on returns of individual asset classes. A bootstrap simulation method was used to create a total of 10,000, 75-year investment horizons, a lifetime of potential investment paths[3]. Each simulated return path was then separately applied to generate 10,000 hypothetical accumulation balances using the following assumptions:

**Table 1: Key Assumptions**

| Variable | Assumption |
|---|---|
| Starting balance | $0 |
| Starting salary | $30,000 |
| Salary growth rate | 4% p.a. |
| Contribution rate | 9% p.a. |
| Starting age | 25 years |
| Retirement age | 65 years |
| Investment horizon | 75 years |
| ASFA Comfortable Living Standard* | $40,121 |
| Inflation | 3% p.a. |

*As at June 2011, Association of Superannuation Funds of Australia (2011).

Scenario analysis was the undertaken to test the impact on the final account balance of a one-off negative return[4]. This 'forced' return was imposed in every fifth year of all 10,000 wealth

[2] To resample returns, this paper uses an updated version of the dataset of nominal returns for Australian stocks, bonds, and bills originally compiled by Dimson, Marsh, and Staunton (2002). The returns include reinvested income and capital gains.

[3] Bootstrap simulation is a process of randomly sampling with replacement from a dataset to create multiple synthetic return paths (Efron and Tibshirani, 1993). This method is used widely in the literature, for instance, see Basu and Drew (2009) and Basu, Byrne and Drew (2011).

[4] Specifically, a 'forced' negative return was input into the same year of all 10,000 paths and final account balance and longevity risk were evaluated. For simplicity, taxation, management fees and transaction costs are excluded from the calculations.

paths in the *accumulation* (Tables 2 & 3) and *decumulation* (Table 4) phases. The annual withdrawals upon retirement from the account were held constant with an adjustment for inflation of three percent. The decision to impose constant real withdrawals is a conservative approach as most data shows that spending tends to decrease with age during retirement[5]. It is important to note that the lowest annual return for any of the portfolios in the sample period (1900 through 2009) was -21.6%. This minimum annual return value (-21.6%) is used as the single sequencing risk event, and was forced upon all 10,000 75-year investment horizons at five year intervals. Longevity risk was assessed by finding the percent of portfolios with a nil balance – throughout referred to as the probability of portfolio ruin – at the ages: 70, 75, 80, 85, 90, 95 and 100, respectively. Again, this approach was taken for every scenario.

**Results**

The key finding of this baseline study is, as one would expect, that sequencing risk has an association with longevity risk, and confirms the findings of current literature in the field (Basu & Drew 2009, De Waegenaere et al., 2010 and Basu, Byrne & Drew, 2011). Table 2 provides the descriptive statistics of the 10,000 wealth paths and the differences between the terminal wealth of each scenario and the base year in percentage terms. Year five represents the base year and result from the sequencing risk event (a -21.6% return) being forced upon every wealth path in the fifth year of accumulation (investor at age 30). The sequencing risk event was then imposed every fifth year after the base year (successively, years 10, 15, ..., 40), with the base year used to calculate a percentage impact.

[5] For further discussion see Australian Bureau of Statistics (2011).

**Table 2: Wealth Paths - Negative Sequencing Event During the Accumulation Phase**

Table 2 provides outcomes for all 10,000 wealth paths when the single sequencing risk event (-21.6% return) has been forced in every fifth year of the *accumulation* phase (Year 5 is the base year for comparison).

| Wealth Path | Mean | Median | Minimum | Maximum | Standard Deviation |
|---|---|---|---|---|---|
| Year 5 (Base Year) | $2,186,750 | $1,861,017 | $164,497 | $13,923,948 | $1,455,909 |
| Year 10 | -7.0% | -6.8% | -19.3% | 0% | 2.2% |
| Year 15 | -12.0% | -12.2% | -26.0% | 0% | 3.6% |
| Year 20 | -15.6% | -16.0% | -29.6% | 0% | 4.3% |
| Year 25 | -17.3% | -19.1% | -32.3% | 0% | 4.9% |
| Year 30 | -20.4% | -21.5% | -34.0% | 0% | 5.2% |
| Year 35 | -22.1% | **-23.4%** | -34.6% | 0% | 5.5% |
| Year 40 | -23.5% | **-24.8%** | -35.2% | 0% | 5.6% |

Table 2 highlights the impact of a single negative event has on the retirement outcomes for superannuants. For the mean and median paths, a 20-25% decrease in final account balance can occur from experiencing a shock in the final 10 years of accumulation, compared to the investor experiencing this event in the fifth year of their accumulation journey. As expected, this impact can be higher for the minimum terminal wealth path as compared to shock being experienced in Year 5.

There are two approaches to consider when analysing the decumulation phase. The first is to assume the withdrawal period is constant, implying variable annual withdrawals so that the portfolio lasts for a given withdrawal period. The second is to withdraw from the portfolio at a constant rate, leaving the withdrawal period to vary. When the withdrawal period is held constant, it was found that withdrawals were impacted to approximately the same degree as the final account balances shown in Table 2[6]. For instance, with sequencing risk event occurring in the 40th year of accumulation (age 65), annual withdrawals would be around 23% less than the base year. It is our conjecture that the second case, where withdrawals are held constant, is the more realistic situation because for the average retiree longevity is unknown, and a decision has to be made about the rate of withdrawal. In this section of the baseline study, it is assumed that the retiree will withdraw at the rate of the Association of

[6] The compounding effect within the undrawn balance added little to the portfolio's longevity.

Superannuation Funds of Australia (2011) comfortable living standard for a single person, indexed for inflation for 40 years. Every year from retirement (age 65) until age 100 was analysed. The only variable in this paper is the sequence of returns, and thus the asset allocation weightings of 70% equities/20% bonds/10% cash respectively remain constant into retirement. For simplicity the withdrawals were assumed to be made once at the end of each year. The number of portfolios with a balance of $0 or less at the end of each year was counted to provide a percentage of portfolios in ruin. Table 3 illustrates the findings, reporting every fifth year into the decumulation phase.

**Table 3: Longevity Risk - Negative Sequencing Event During the *Accumulation* Phase**

Table 3 provides a longevity risk analysis, reporting the proportion of the 10,000 portfolios in ruin when subjected to sequencing risk event in every fifth year of the *accumulation* phase (No Sequencing Risk is the base for comparison).

| **Age** | **70** | **75** | **80** | **85** | **90** | **95** | **100** |
|---|---|---|---|---|---|---|---|
| No Sequencing Risk | 1.2% | 10.6% | 21.4% | 29.6% | 35.5% | 39.7% | 42.7% |
| Year 5 | 1.5% | 12.3% | 24.2% | **33.1%** | 39.4% | 43.9% | **46.5%** |
| Year 10 | 1.8% | 14.8% | 27.7% | 37.0% | 43.7% | 48.0% | 51.1% |
| Year 15 | 2.2% | 16.6% | 30.5% | 40.7% | 47.2% | 51.6% | 54.8% |
| Year 20 | 2.6% | 18.3% | 33.3% | 43.2% | 50.0% | 54.4% | 57.9% |
| Year 25 | 3.0% | 20.0% | 35.1% | 45.6% | 53.0% | 57.2% | 60.2% |
| Year 30 | 3.5% | 21.6% | 36.9% | 47.7% | 54.2% | 58.5% | 61.4% |
| Year 35 | 3.9% | 22.8% | 38.4% | 48.9% | 55.6% | 60.0% | 63.2% |
| Year 40 | 4.5% | 23.9% | **39.8%** | **50.6%** | 56.9% | 60.9% | **63.9%** |

The key themes to emerge from the findings reported in Table 3reflect those observed for terminal wealth estimates provided in Table 2. The later the timing of the forced negative return (the sequencing risk event) in the accumulation phase, the greater the chance of ruin for each age. Table 3 shows there is a 46.5% chance the portfolio will be depleted by the age of 100 when the sequencing risk is forced in the fifth year of accumulation (shaded double-line box, Table 3). As expected, there is a greater chance (63.9%) of having the funds completely depleted by 100 when sequencing risk is forced in the 40th year of accumulation (shaded, Table 3). Interestingly, similar probabilities of ruin exist for two very different retirement ages: a shock occurring in the last year of accumulation (Year 40) sees around the same probability of ruin at age 80-85 years, as a shock in the fifth year causes at age 100 years (compare double-line boxes, Table 3). Such probabilities are important in given that the average life expectancy of an Australian is around 85 years[7]. At this age the sequencing risk event occurring in the 5th year resulted in a 33.1% chance of ruin, around 1 in 3 (see single-line box, Table 3). The 40th year sequencing event impact has increased this chance of ruin to 50.6%, now 1 in 2. These estimates confirm that not only does sequencing risk impact final account balance; it also considerably heightens longevity risk for investors.

The analysis to date has provided some preliminary evidence on the impact of a negative shock during the accumulation phase for Australian superannuants, with its impacts on longevity risk being consistent with international evidence (Odenath, 2006; Vickerstaff, 2006; Cheng, 2007; Basu & Drew, 2009). We now move to consider the impact of a negative sequencing risk event that occurs in the *decumulation* phase. As previously noted, we keep portfolio weightings constant in this baseline study to ensure that the *timing* of the single negative shock is the only variable. Table 4 shows the proportion of portfolios in ruin when the minus 21.6% return is applied to every fifth year in the decumulation or post-retirement phase.

**Table 4: Longevity Risk - Negative Sequencing Event During the *Decumulation* Phase**

Table 4 provides a longevity risk analysis, reporting the proportion of the 10,000 portfolios in ruin when subjected to sequencing risk in every fifth year of the *decumulation* phase.

| Age | **70** | **75** | **80** | **85** | **90** | **95** | **100** |
|---|---|---|---|---|---|---|---|
| Year 45 | 1.6% | 17.5% | 33.1% | **44.2%** | 51.0% | 55.8% | 59.1% |
| Year 50 | 1.2% | 11.4% | 26.7% | **38.0%** | 45.3% | 50.2% | 54.0% |
| Year 55 | 1.2% | 10.6% | 22.1% | 33.5% | 41.2% | 46.7% | 50.0% |
| Year 60 | 1.2% | 10.6% | 21.4% | 29.9% | 38.3% | 43.7% | 47.4% |
| Year 65 | 1.2% | 10.6% | 21.4% | 29.6% | 35.8% | 41.6% | 45.4% |

Table 4 highlights the risks faced by investors during their journey through the decumulation phase. If a substantial negative returns occurs five years after retirement (year 45 of the investment horizon; or age 70) the risk of ruin at age 85 grows to 44.2% (shaded, Table 4). The risk of ruin has fallen to below that of the 25th year scenario by around 1.5% (see Table

[7] Data taken from the Mortality Database provided by Australian Institute of Health and Welfare (2011).

3). The risk of ruin at age 85 of a Year 50 shock has fallen to 38.0% (shaded, Table 4), illustrating that after just 10-years of retirement, longevity risk has reduced to the same level as if the shock occurred in around the 10th year of accumulation (see Table 3). These baseline findings suggest that further research is required as a matter of priority to more formally define the retirement risk zone window. In short, the baseline findings suggest that contemporary beliefs of where the typical investor's retirement risk zone lies (10 years pre- and post-retirement), may need to be adjusted to incorporate a greater span of time within the accumulation phase (that is, perhaps 15-20 years pre-retirement and around 5 years post-retirement). Figure 1 illustrates the relationship between the estimated probability of portfolio ruin (y-axis) and the year in which the sequencing risk event was imposed (x-axis). For each series, the probability of ruin rises to its peak at retirement (Year 40, x-axis), after which it falls.

**Figure 1: Longevity Risk - Negative Sequencing Event Across the Lifecycle**

Figure 1 plots longevity risk estimates when investors are subjected to a -21.6% return sequence at different five year points in the investing lifecycle, that is, both *accumulation* and *decumulation* phases.

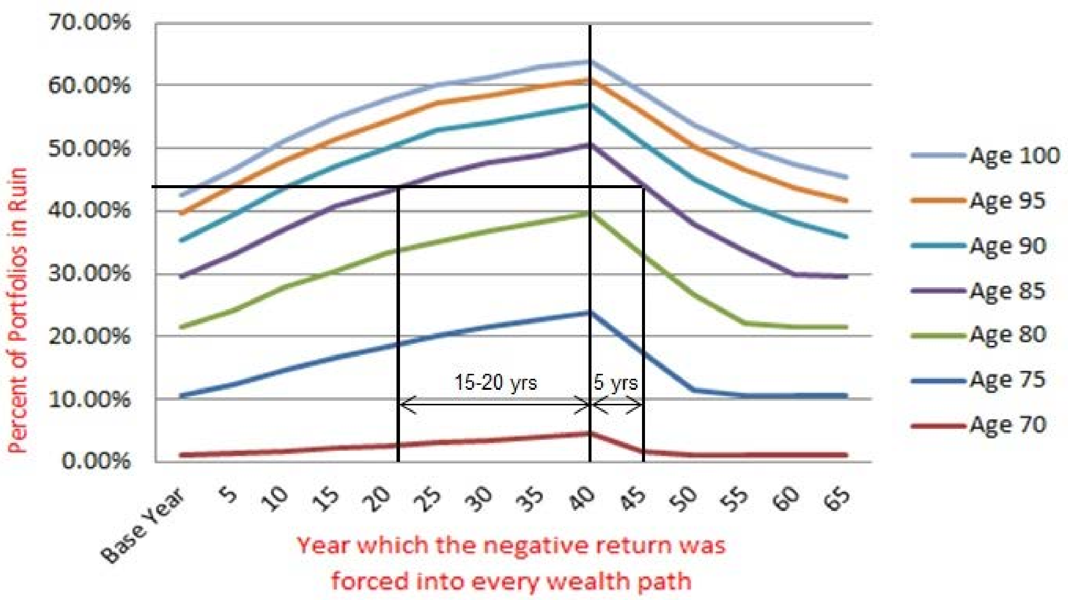


Figure 1 suggests an asymmetry in the impact of sequencing risk in pre-and post-retirement phases. Consider the horizontal line which bisects the (purple) Age 85 series pre- and post-retirement. This line identifies the shock timing, pre- and post-retirement, which results in equal probabilities of ruin at age 85. This asymmetry suggests that superannuants are exposed to the potentially negative consequences of sequencing risk earlier in the accumulation phase than conventional wisdom suggests (again, we reiterate the caveat that these are baseline estimates and will change given different member circumstances).

The baseline results also suggest that the risk of portfolio ruin declines comparatively rapidly the later a sequencing risk event occurs in the decumulation phase. One year either side of retirement sees, as expected, a fairly similar risk of portfolio ruin (that is, when the negative sequencing event occurs in the retirement year the highest probability of ruin is observed). Interestingly, just two years after retirement (Year 42, Age 85 series) the risk of ruin has fallen to 48.3%; roughly equivalent to a sequencing risk event occurring in the 32nd year of accumulation (8 years pre-retirement). Some ages, such as 80, 95 and 100 actually show that the year just after retirement is the most risky. Again, it is important to note that these results assume that the withdrawals are made once at the end of each year and thus the first withdrawal would not occur till the end of the 41st year and hence this year would have the largest account balance.

**Concluding Comments**

We live in a time of great reform in superannuation. The Australian retirement savings system that came to life in the early 1990s is maturing from teenage to adulthood. And with adulthood comes additional responsibility: how do we design default options that efficiently and effectively manage the dynamic nature of risk as we progress through our investing lifetime? What is the super fund's strategy for managing the portfolio size effect, the critical conversion journey from pre- to post-retirement? And, given the challenges of sequencing risk, what specific strategies are employed to limit the impact of the next major bear market?

These issues are challenging for members, trustees and regulators alike and represent the priority items on board of trustee agendas of leading superannuation funds around the country. This paper attempts to provide some baseline analysis to provide some definition of the risks facing members in the retirement risk zone.

We find that members are exposed to a very real risk of an inopportune sequence of returns. The baseline results suggest that the order in which returns are experienced play a crucial role in achieving retirement adequacy. Perhaps the key take away from the study is that just a single, poorly-timed negative return event (of around -20%) can raise the probability of ruin from 33% to 50% for average life expectancy.  The baseline findings also raise questions regarding where the retirement risk zone truly lies.  We would encourage future researchers to test the efficacy of the simply baseline findings presented in this study (again, we have acknowledged throughout the paper that the motivation was to commence a program of research).  As a matter of priority, the asymmetry of the impact of sequencing risk on retirement outcomes across the retirement risk zone is worthy of further investigation.

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