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THE RETIREMENT RISK ZONE: A BASELINE STUDY

This paper undertakes a baseline study to explore the heady mix of the portfolio size effect and sequencing risk facing superannuants within the retirement risk zone. It explores the impact on retirement outcomes when portfolios are subjected to a single sequencing risk event at different points through a member's investing life. We report sensitivities between the timing (or sequence) of a negative return event on terminal wealth outcomes and the associated impact on longevity risk. Our findings suggest that greater priority needs to be given to sequencing risk earlier in a member's accumulation phase than convention suggests.[1]

BRETT DORAN is an Honours student in the Department of Accounting, Finance and Economics, Griffith Business School, Griffith University. Email: brett.doran@griffithuni.edu.au

MICHAEL E. DREW SF Fin is Professor of Finance in the Department of Accounting, Finance and Economics, Griffith Business School, Griffith University. Email: michael.drew@griffith.edu.au

ADAM N. WALK F Fin is a PhD candidate in the Department of Accounting, Finance and Economics, Griffith Business School, Griffith University. Email: a.walk@griffith.edu.au

As investors, we walk a tightrope in seeking to take 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 at which it 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 past 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 was never more evident than during the global financial crisis (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 and Drew (2009) has drawn attention to one particular feature of the dynamics of retirement investing: the portfolio size effect. Basu and Drew (2009) found 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. A large and rapidly growing portfolio size is exactly what superannuation fund members seek to achieve in order to fund an adequate retirement income. However, when the portfolio size effect is combined with an unfavourable sequence of returns ('sequencing risk', see Macqueen and Milevsky 2009), this goal is jeopardised. Today, investors aged in their late 50s/early 60s, with a growth-oriented asset allocation, have borne the brunt of a decade of various financial crises — these are clear examples of sequencing risk events that have affected their retirement nest egg and thus the sustainability of their retirement income.

The portfolio size effect and sequencing risk have a direct relationship with longevity risk. 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 that longevity risk manifests itself is when an investor's superannuation savings are subject to a major negative market event within the retirement risk zone. A smaller pool of retirement savings will, all other things being equal, 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.[2] The baseline approach adopted explores the variable effects on retirement outcomes that occur 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 affects 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. We argue 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 et al. 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.

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Data and method

This paper examines the impact of sequencing risk on a hypothetical investment portfolio with a constant asset allocation (rebalanced annually) as follows: 70 per cent Australian equities, 20 per cent Australian bonds and 10 per cent Australian cash. Over a century of annual returns for these respective asset classes (1900 through 2009) was used.[3] 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.[4] Each simulated return path was then separately applied to generate 10,000 hypothetical accumulation balances using the following assumptions identified in Table 1.

Scenario analysis was then undertaken to test the impact on the final account balance of a one-off negative return.[5] This 'forced' return was imposed at a single point in time (at five-year intervals from year 5 onward) for all 10,000 wealth paths in the accumulation (Tables 2 and 3) and decumulation (Table 4) phases. This approach allows us to observe the impact of the timing of a single shock when it occurs in successively later intervals in the investing life cycle. The annual withdrawals from the account upon retirement were held constant with an adjustment for inflation of 3 per cent. The decision to impose constant real withdrawals is a conservative approach as most data shows that spending tends to decrease with age during retirement.[6] 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 per cent. This minimum annual return value (-21.6 per cent) is used as the single

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).

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 percentage of portfolios with a nil balance — throughout this paper, referred to as the probability of portfolio ruin at age 70, 75, 80, 85, 90, 95 and 100, respectively. Again, this approach was taken for every scenario.[7]

Results

The key finding of this baseline study is that sequencing risk has an association with longevity risk, and this confirms the findings of current literature in the field (Basu and Drew 2009, De Waegenaere et al. 2010 and Basu et al. 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 5 represents the base year and result from the sequencing risk event (a -21.6 per cent return) being forced upon every wealth path in the fifth year of accumulation (investor at age 30). The sequencing risk event was then imposed in year 10, then year 15, and so on, with the base year being used to calculate a percentage impact.

Table 2 highlights the impact of a single negative event on the retirement outcomes for superannuants. Following a shock in the final 10 years of accumulation, an investor can experience a 20–25 per cent decrease in average final account balance relative to experiencing this event in the fifth year of his or her accumulation journey. As expected, this impact can be higher for the minimum terminal wealth path as compared with the shock being experienced in year 5.

There are two approaches to consider when analysing the decumulation phase. The first is to assume that 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, withdrawals are affected to approximately the same degree as the final account balances shown in Table 2.[8] For instance, with the sequencing risk event occurring in the 40th year of accumulation (age 65), annual withdrawals are around 23 per cent less than in the base year. We surmise that the second approach, in which withdrawals are held constant, is more realistic 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, we assume that the retiree will withdraw at the rate estimated by the Association of Superannuation Funds of Australia (2011) to provide a comfortable living standard for a single person, indexed for inflation for 40 years. We analysed every year from retirement (age 65) until age 100. The only variable

Table 2: Impact on terminal wealth of a negative sequencing event during the accumulation phase

Wealth path (year of risk event)	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%

Note: Table 2 provides outcomes for all 10,000 wealth paths when the single sequencing risk event (-21.6 per cent return) has been forced to occur in one year of the accumulation phase (year 5 is the base year for comparison).

Table 3: Probability of ruin — negative sequencing event during the accumulation phase (*No sequencing risk is the base year 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%

Note: Table 3 provides a longevity risk analysis, reporting the proportion of the 10,000 portfolios in ruin when subjected to a single sequencing risk event applied at five-year intervals in the accumulation phase.

in this paper is the sequence of returns, and thus the asset allocation weightings of 70 per cent equities/20 per cent bonds/10 per cent cash, respectively, remain constant into retirement. For simplicity, we assumed that withdrawals are made once only at the end of each year. We counted the number of portfolios with a balance of $0 or less at the end of each year to provide a percentage of portfolios in ruin. Table 3 illustrates the findings, reporting every fifth year into the decumulation phase.

The key themes to emerge from the findings reported in Table 3 reflect those observed for the terminal wealth estimates that are provided in Table 2. The later the timing of the forced negative return (the sequencing risk event) in the accumulation phase, the greater is the chance of ruin for each age. Table 3 shows that when the sequencing risk is forced in the fifth year of accumulation (shaded double-line box, Table 3), there is a 46.5 per cent chance that the portfolio will be depleted by the age of 100. As expected, when the sequencing risk is forced in the 40th year of accumulation (shaded, Table 3), there is a greater chance (63.9 per cent) of having the funds completely depleted by the age of 100. Interestingly, similar probabilities of ruin exist for two very different retirement ages: a shock occurring in the last year of accumulation (year 40) produces 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 given that the average life expectancy of an Australian is around 85 years.[9] At this age, the sequencing risk event occurring in the 5th year resulted in a 33.1 per cent chance of ruin, around 1 in 3 (see single-line box, Table 3). If the sequencing risk event occurs in the 40th year, the chance of ruin rises to 50.6 per cent, now 1 in 2. These estimates confirm not only that sequencing risk affects the 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 effects on longevity risk being consistent with international evidence (Odenath 2006, Vickerstaff 2006, Cheng 2007, Basu and Drew 2009). We now 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 -21.6 per cent return is applied to every fifth year in the decumulation or post-retirement phase.

Table 4 highlights the risks faced by investors during their journey through the decumulation phase. If a substantial negative return 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 per cent (shaded, Table 4). The risk of ruin has fallen to below that of the 25th year scenario by around 1.5 per cent (see Table 3). The risk of ruin at age 85 of a year 50 shock has fallen to 38.0 per cent (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 five 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.

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 five years post-retirement).

Table 4: Probability of ruin — negative sequencing event during the decumulation phase

Age (year of risk event)	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%

Note: Table 4 provides a longevity risk analysis, reporting the proportion of the 10,000 portfolios in ruin when subjected to a single sequencing risk event at different times in the decumulation phase.

Figure 1: Probability of ruin — negative sequencing event across the life cycle

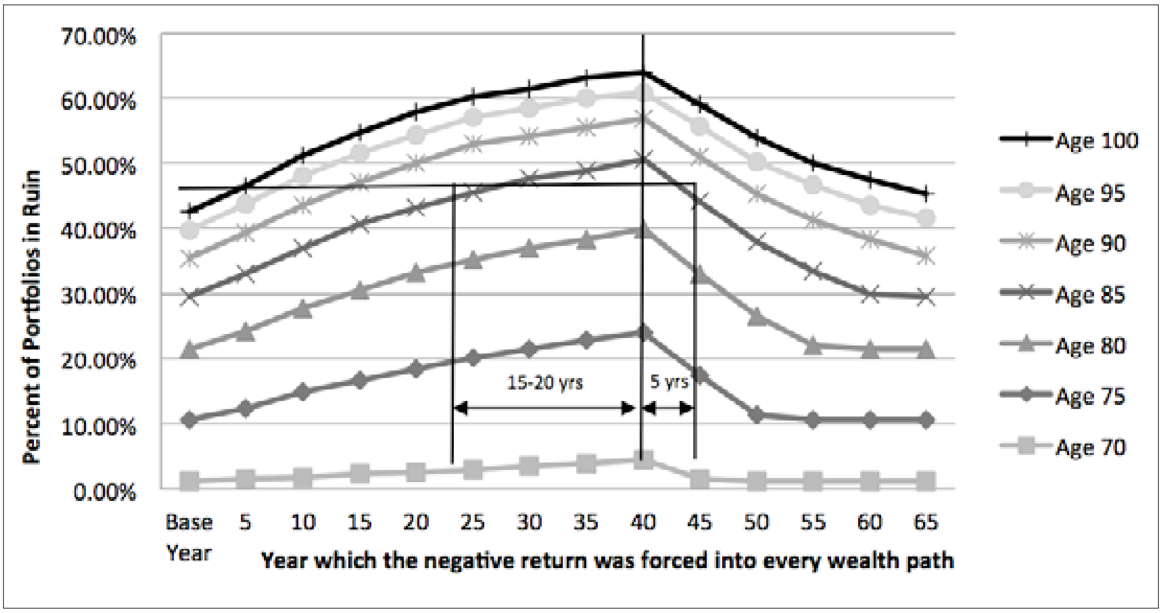

Figure 1 plots longevity risk estimates when investors are subjected to a -21.6 per cent return sequence at different five-year points in the investing life cycle; that is, in both the accumulation and decumulation phases.

Figure 1 suggests an asymmetry in the impact of sequencing risk in the pre- and post-retirement phases. Consider the horizontal line which bisects the 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. As expected, a shock occurring one year either side of retirement, produces a fairly similar risk of portfolio ruin (that is, the highest probability of ruin is observed when the negative sequencing event occurs in the retirement year). Interestingly, just two years after retirement (year 42, age 85 series) the risk of ruin has fallen to 48.3 per cent; roughly equivalent to a sequencing risk event occurring in the 32nd year of accumulation (eight years pre-retirement). For some age series, such as 80, 95 and 100, the year immediately 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. Thus the first withdrawal would not occur until the end of the 41st year and this year would have the largest account balance.

Concluding comments

The Australian retirement savings system that emerged in the early 1990s is maturing and undergoing a period of significant reform. As part of this reform, a number of critical issues need to be addressed. How can 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 should be employed to limit the impact of the next major bear market?

These issues are challenging for members, trustees and regulators alike and are the priority items on the agenda of boards of trustees of leading superannuation funds around the country. This paper seeks to provide a baseline analysis to help define 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 occur plays a crucial role in achieving adequacy in retirement funding. It is important to note that for average life expectancy, a single, poorly timed negative return event (of around -20 per cent) can raise the probability of ruin from 33 per cent to 50 per cent. The baseline findings also raise questions regarding the scope of the retirement risk zone. We would encourage future researchers to test the efficacy of the simple baseline findings presented in this study. 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. ∎

Notes

1. We thank the Managing Editor, Professor Kevin Davis, and an anonymous reviewer, for helpful comments and suggestions. All errors remain the sole responsibility of the authors.
2. 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
3. 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 et al. 2002. The returns include reinvested income and capital gains.
4. 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 et al. (2011).
5. 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.
6. For further discussion see Australian Bureau of Statistics (2011).
7. It is important to note two issues regarding the methodology employed. First, that there are other paradigms within which this problem can be examined, for instance an expected utility framework. And, second, the assumptions underlying this model are highly simplified (e.g. constant salary growth and constant withdrawals). Our motivation is to provide baseline findings in the Australian setting that can be used by future researchers to advance the portfolio size debate.
8. The compounding effect within the undrawn balance added little to the portfolio's longevity.
9. Data taken from the *Mortality Database Life Tables* provided by Australian Institute of Health and Welfare (2011). It should also be noted that the probability of ruin by a particular age is based on simulations involving all portfolios, and not allowing for the probability that individuals might die before that date. It provides a probability of ruin for individuals who have survived to that age but not, for example, the probability of ruin at age 85 of an individual currently aged 65.

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