Risk and Retirement Income

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January 2016

Throughout a person's working life, retirement income planning revolves around the questions: How much do I need to save to live on when I am no longer relying on paid employment? And where should I invest it in the meantime? Retirement calculators, like those provided by www.sorted.org.nz and other websites, assist with that deliberation, and financial advisers can provide detailed advice and then help with implementation of an investment strategy.

Financial decision-making for the next phase of life has received less public attention: If I was to retire from paid work now, what sustainable level of income would my investment portfolio support? And where should I invest it? These are reasonable and straightforward questions to ask. However, answering them with any confidence requires sorting through a whole range of factors, including portfolio allocation, risk tolerance, inflation, super scheme rules, public pensions, taxes, insurance, home ownership, lumpy or unanticipated expenditure requirements, legacies, financial market returns and volatility, and uncertainty about your future health and longevity: A very complex calculation.

This note addresses a small, but important, part of this calculation: the implications of risk in determining a sustainable income level from a given portfolio of wealth. I use a simplified scenario to work through four levels of sophistication, starting with expected values, then successively taking account of longevity risk, financial market return volatility, and their interaction. I finally consider the implications of portfolio choice.

The key insights are:

- Risk matters in that the sustainable annual drawing rate is lower when risk is taken into account. Planning just on the basis of expected values of investment returns and longevity is therefore not advisable.
- However, once financial volatility and longevity risk are taken into account, a more risky financial portfolio actually may lead to a better outcome on the risk-return relationship that ultimately matters; that is, maximising the sustainable rate of annual drawings from your financial portfolio while minimising the likelihood of the portfolio being exhausted before you die. This challenges the accepted wisdom that one should move inevitably to a more conservative investment portfolio in retirement.

The Scenario

A woman has $1,000,000 invested in a balanced portfolio that meets her risk appetite. The portfolio has an expected annual return of 5.6% and volatility of 9.2%. She is age 55 years and her life expectancy is consistent with the Statistics NZ projected life tables for a New Zealand European woman. What level of income can she draw annually for the rest of her life?

Level One: Expected Values

The expected annual return on the portfolio is 5.6% and, according to the projected life tables, her expected (weighted average) age of death is at 85 years, that is, in 30 years' time. A simple formula can

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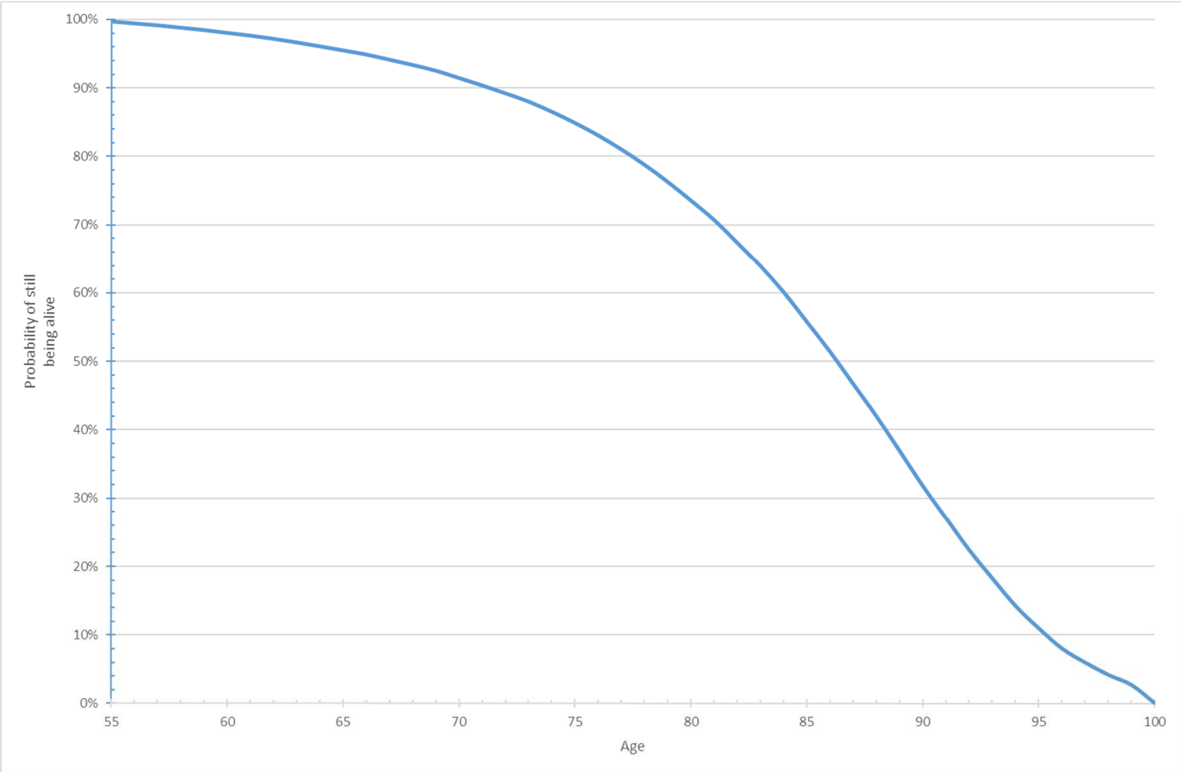
be used to show that, if she draws $65,878 at the start of each year and consistently earns 5.6% per year on her declining portfolio balance, she will exhaust her $1,000,000 portfolio in 30 years.[2]

Level Two: Expected Returns with Longevity Risk

Having a life "expectancy" of 30 years means that there is about a 50% probability[3] that she will live longer, possibly much longer, than 30 more years. The following graph, based on the NZ European female projected life tables, depicts the probability that she will still be alive at each year into the future, given that she has lived to age 55.



The life tables project a probability of 5% that she will still be alive at age 98, some 13 years after her money would have run out if she had drawn $65,878 per year. In order for her to have 95% confidence that her portfolio will last her lifetime, her funds would need to last and provide income up to age 98. Using the same calculation as for Level One, her drawing rate would need to be $58,664 per year. The result of this is that there is only a 5% chance that she will live long enough to exhaust her portfolio before she dies. However, she would probably die with a fairly significant portfolio remaining ($560,000 on average, assuming a consistent 5.6% return).

The following graph illustrates how her portfolio would wind down over time with an annual drawing rate of $58,664 and consistent returns of 5.6% per year.

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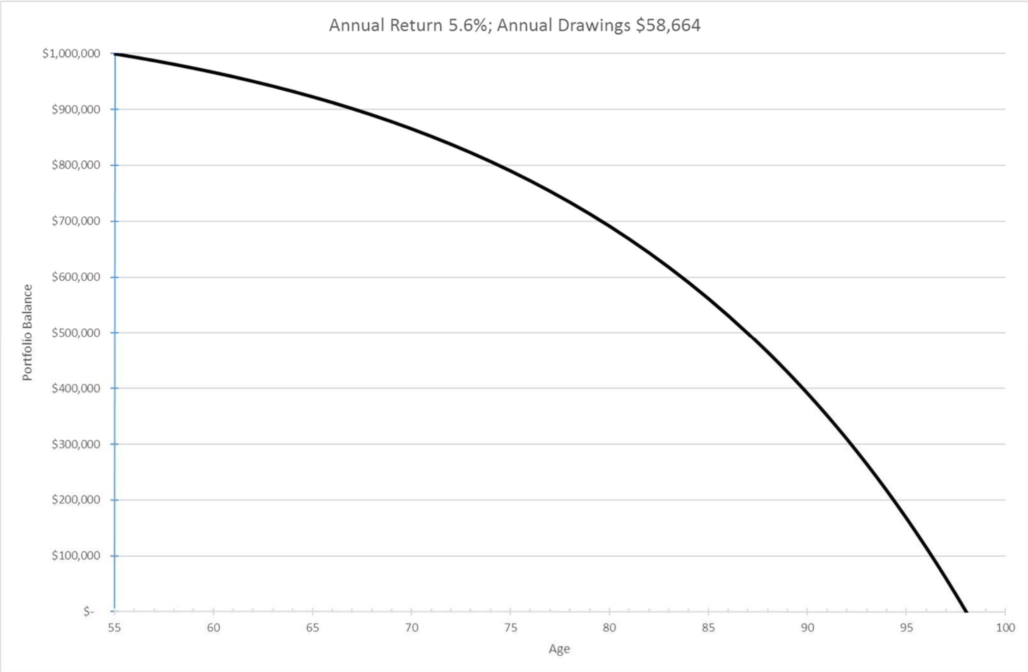
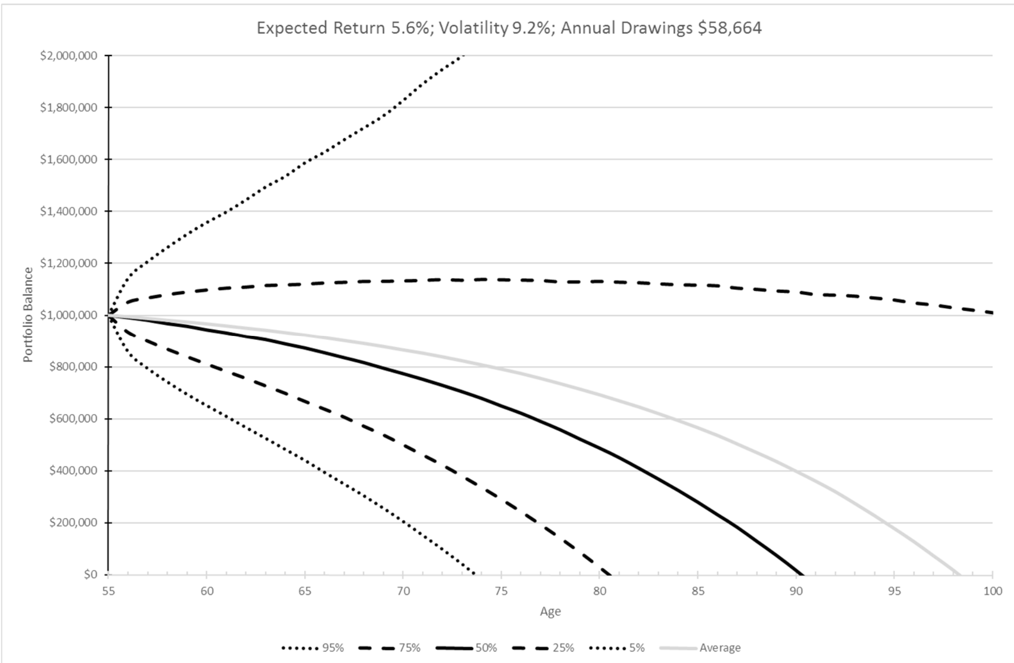
[2] $d = \frac{Wr(1+r)^{t-1}}{(1+r)^{t}-1}$ where *d*=annual drawing rate; *W*=initial wealth ($1,000,000); r=annual rate of return (5.6%); t=number of years (30).

[3] The mortality distribution is slightly skewed, so the expected value of her age of death is a year or so less than the median age. Her probability of living longer than 30 more years is about 56%.



Level Three: Volatility of Returns

The above analyses assume that she will consistently earn the "expected" return each year. However, her portfolio actually has annual volatility of 9.2%. Compounded over two or three decades, this volatility leads to a wide range of possible outcomes for her portfolio, as illustrated by the percentiles in the following chart. This chart starts with her $1,000,000 portfolio and has an expected return of 5.6% per year with volatility of 9.2% per year. It assumes she draws $58,664 per year, the amount calculated previously as being enough to last until age 98 (or 43 years), the 95th percentile of her life expectancy.[4]

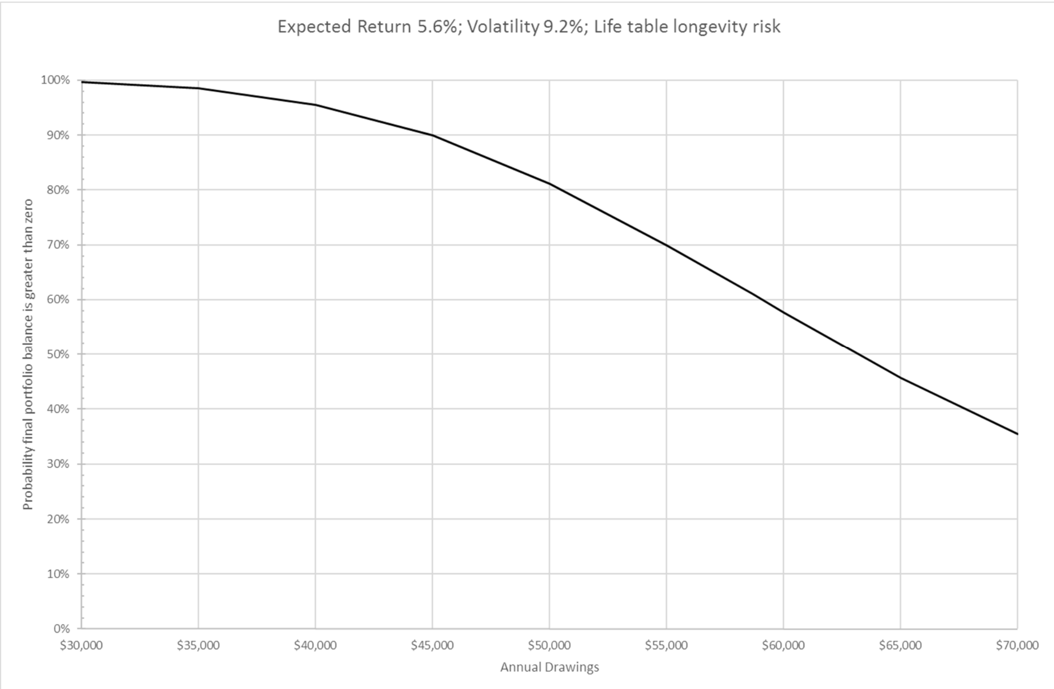


[4] The calculations and graphs presented in this note that are not able to be derived analytically are based on monte carlo simulations using 50,000 draws and assuming that investment returns follow a lognormal distribution.

Consistent with the Level Two analysis, her average portfolio balance (the grey line) reaches zero at age 98.[5] However, there is a very wide range of possible outcomes, including a 25% probability that her portfolio will be exhausted by around age 80, which is some time before her average life expectancy of 85. If she does reach age 98, there is a 60% probability that her portfolio will have been exhausted already, but a 25% probability that her portfolio balance will still be at least $1,000,000 (and possibly significantly more).

Level Four: Return Volatility and Longevity Risk

Levels Two and Three looked separately at longevity risk and return volatility. We need to consider these two risks jointly in order to arrive at an appropriate annual drawing rate. The following chart takes into account both return volatility and longevity risk and shows the probability that the portfolio will outlast her life for a range of drawing rates.



At the drawing rate of $65,878 that was assessed at Level One, which ignored both return volatility and longevity risk, the probability of her portfolio lasting until she dies is now seen to be 44%. Her Level Two drawing rate of $58,664 took into account longevity risk at the 95% level. However, that ignored return volatility. Once that is taken into account as well, the probability of her portfolio lasting at this drawing rate until she dies is only 61%. In order to have 95% confidence that her portfolio will last until she dies, she would need to set her annual drawing rate to $40,600.

Level Five: Portfolio Choice

The analysis so far has assumed that she has made a prior decision about her portfolio allocation to a balanced portfolio with expected return of 5.6% per year and annual volatility of 9.2%. An annual drawing rate of $40,600 is only 4.06% of her $1,000,000 portfolio, which is less than her 5.6% expected return. This raises a question of whether she would be better off with a lower return volatility, albeit with corresponding lower expected annual returns.

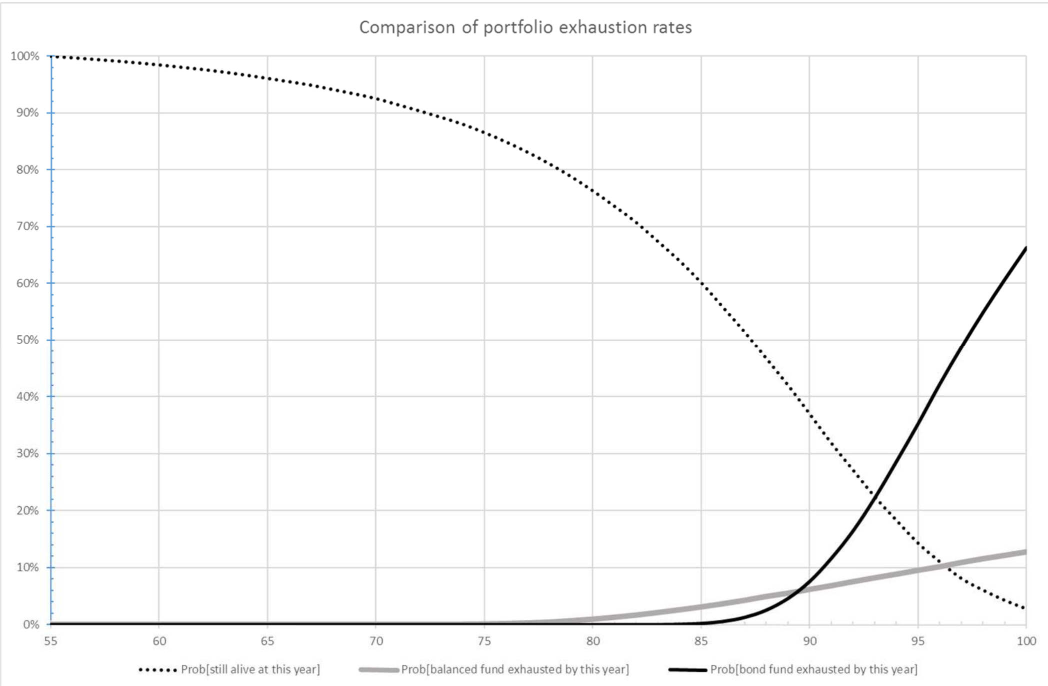
[5] The average is greater than the median because of the lognormal distribution of returns.

The following table reassesses the key results from above, assuming she instead invests her savings in a bond portfolio with expected annual return of 3.0% and annual volatility of 2.5%.

Annual Expected Return **Annual Volatility**	**5.6%** **9.2%**	**3.0%** **2.5%**
<u>Level One: Expected Values</u> Annual drawing rate with fixed return at expected rate and known life to 85 years:	$65,878	$49,533
<u>Level Two: Longevity Risk</u> Annual drawing rate for portfolio to last to 95th percentile of life table, with fixed return at expected rate:	$58,664	$40,484
<u>Level Four: Return Volatility and Longevity Risk</u> Annual drawing rate for 95% probability that portfolio will last to death: Probability that a drawing rate of $40,600 will last to death:	 $40,600 95%	 $38,100 86%

The conclusion to draw is that, while the annual financial risk of her "balanced" portfolio is higher than that of a "bond" portfolio, the balanced portfolio performs better on the risk that ultimately matters. Specifically, the higher risk portfolio provides a higher probability that her portfolio will not be exhausted before her death.

The following graph compares the performance of the two portfolios across the age distribution, with annual drawings of $40,600.



This graph illustrates that the probability of the balanced portfolio being exhausted remains low across the age distribution, with an average probability of being exhausted (weighted by probability of death) of 5%. In contrast, the bond portfolio presents an increasingly significant chance of being exhausted before death, with a weighted average probability of about 14%.

The conclusion that investing in a portfolio posing greater financial risk actually might achieve a lower risk retirement income outcome runs counter to the accepted wisdom that you should move to a more conservative (that is, lower risk/lower return) financial portfolio when you retire. The reason for this apparent contradiction can be seen by comparing how the distributions of portfolio balance evolve over time:

- The bond portfolio (top graph on the next page) tends to track down over time because the annual drawings of $40,600 are greater, on average, than the investment returns. It maintains a relatively tight distribution, reflecting its low volatility.
- The balanced portfolio (lower graph on next page) has a much wider dispersion than the bond portfolio, reflecting the greater volatility. However, potential for a poor outcome that matters (that is, running out of money before she dies) is lower with the balanced portfolio than with the bond portfolio, especially as the time horizon increases.[6]

The Next Level: A Dynamic Strategy

The reality of retirement income planning is that it is not a "set and forget" exercise. It is something that needs to be revisited periodically and recalibrated. For example, if the person in my scenario above experiences a period of better than expected financial portfolio performance, she might be able to sustain a higher ongoing annual drawing rate. Conversely, poor returns might require pulling back of the annual drawing rate.[7] Analysis of the implications of a dynamic strategy is something for a future note.

Conclusions

Some caveats: This analysis is illustrative. It abstracts away from the host of factors that matter in retirement income planning in order to focus in on a few key points. It should therefore not be considered on its own as investment advice.

However, the analysis does draw of some stylised facts to think about in the course of retirement income planning:

- Risk matters in that the sustainable annual drawing rate is lower when risk is taken into account. Planning just on the basis of expected values of investment returns and longevity is therefore not advisable.
- However, once financial volatility and longevity risk are taken into account, a more risky financial portfolio actually may lead to a better outcome on the risk-return relationship that ultimately matters; that is, maximising the sustainable rate of annual drawings from your financial portfolio while minimising the likelihood of the portfolio being exhausted before you die. This challenges the accepted wisdom that one should move inevitably to a more conservative investment portfolio in retirement.

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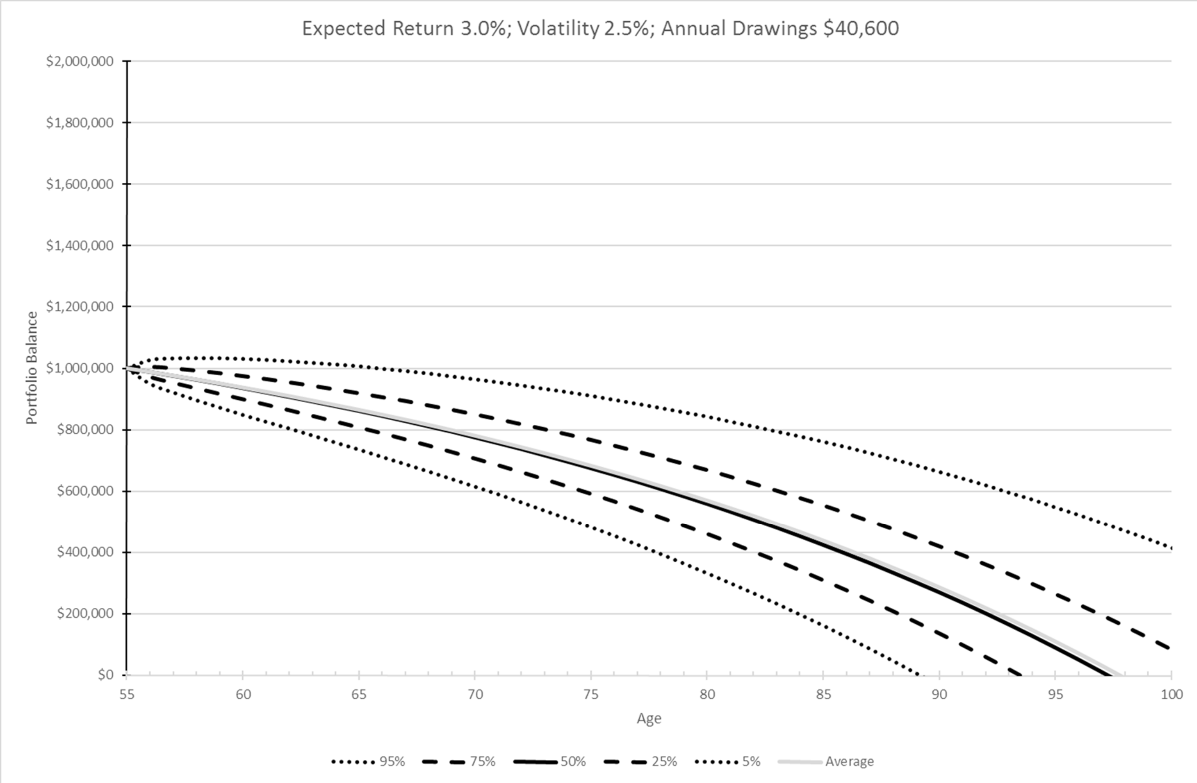
[6] The distribution of the balanced portfolio tends to track up over time because the annual drawings are less, on average, than the investment returns.

[7] Each year she survives, she will be one year further down the projected life tables, which could also have a minor effect on the calculations.


Expected Return 3.0%; Volatility 2.5%; Annual Drawings $40,600
Portfolio Balance
$2,000,000
$1,800,000
$1,600,000
$1,400,000
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
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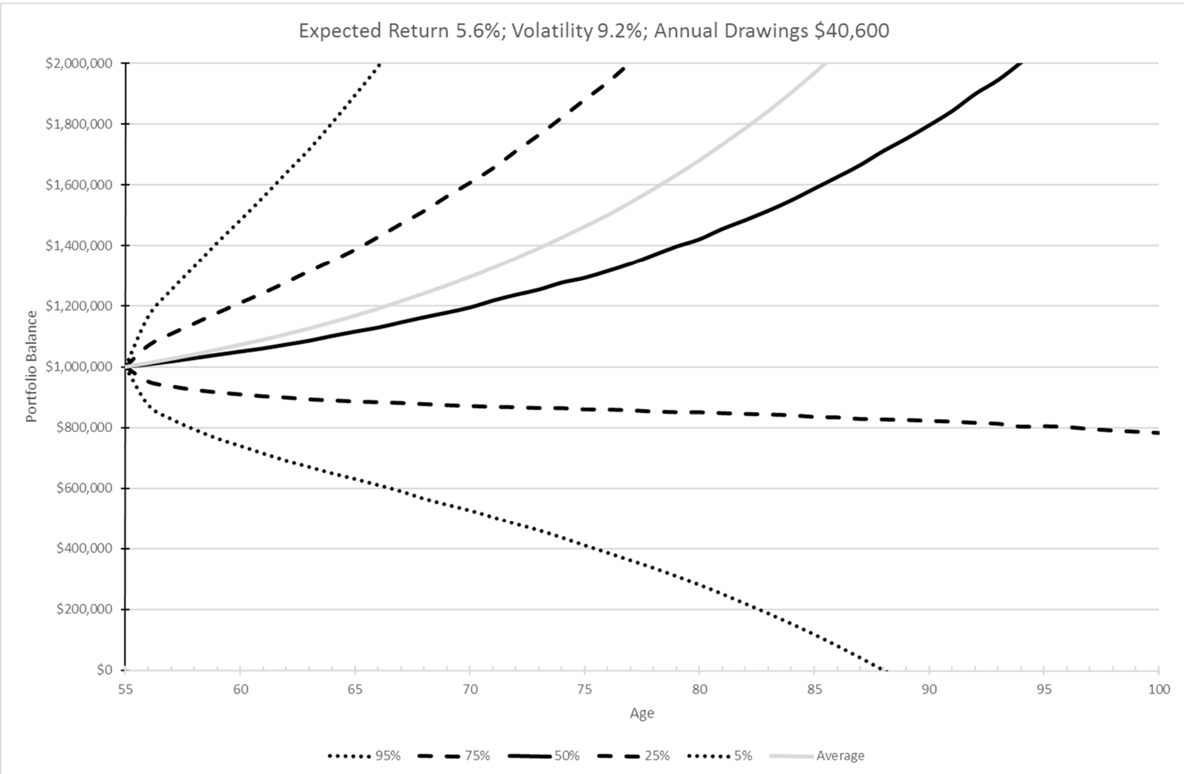
50%
25%
5%
Average


Expected Return 5.6%; Volatility 9.2%; Annual Drawings $40,600
Portfolio Balance
$2,000,000
$1,800,000
$1,600,000
$1,400,000
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
55
60
65
70
75
80
85
90
95
100
Age
95%
75%
50%
25%
5%
Average