Measuring Success in Decumulation: The Minimum Acceptable Annual Withdrawal Rate (MAAW)

by[1]

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Abstract

This paper proposes a new method of assessing the sustainability of withdrawals from a given pot of wealth in retirement or indeed in any similar context such as intergenerational family wealth or charity/endowment spending. We use the recent concept of Perfect Withdrawal Rates to assess appropriate withdrawal amounts year by year based on changing returns and (probably) in conversation with an adviser. The preferred withdrawal strategy is 'adaptive' and the focus here is on devising a new measure of success of a portfolio retirement strategy which reflects the aspirations of both retiree and adviser in their practical communications. We introduce a new measure of success to gauge how well a withdrawal strategy performs against a target withdrawal amount, the Minimum Acceptable Annual Withdrawal Rate (MAAW). We suggest that this offers a very practical and intuitively appealing measure of success for the performance of portfolios in the decumulation context.

Key words:
Sequence Risk; Longevity Risk, Withdrawal Risk, Delayed Annuities, Adaptive Withdrawals

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1. Introduction

This paper proposes a new method of assessing the sustainability of withdrawals from a given pot of wealth in retirement or indeed in any similar context such as intergenerational family wealth or charity/endowment spending. The issue of how much can one withdraw without running out of money in decumulation has been typically discussed in the retirement literature. The fundamental question addressed revolves around what percentage of an initial pot of wealth can one withdraw each year over a given period of time (say 20 years) with a given portfolio of assets (say 50-50 equity/bonds)? Bengen's (1994) initial research started an extensive literature and showed that for such a portfolio (for the US with a 50-50 stock/bond portfolio in the 20th century) one would not run out of money over any period of 30 years given US returns' experience when withdrawing 4% of the initial starting pot each year. This became known as the '4%-rule' with much research following on by country, decumulation period and portfolio composition (see, for example, Estrada, 2018 and Clare et al, 2021). Of course, this may be considered sub-optimal as wealth may be 'left over' (though of course this may satisfy a bequest motive). Hence, a recent literature is beginning to explore the use of deferred annuities and indeed later-life conventional annuities to provide integrated longevity protection, (see Chen et al, 2016, Totten and Siegel, 2019 and Waring and Siegel, 2015). There is no obvious measure of success other than avoiding running out of money: i.e. a yes/no measure.

This 'constant withdrawal' approach is of course unrealistic in that conversations with a financial adviser will highlight their possibly unsustainable nature in a world where returns prove disappointing and wealth is disappearing fast. Of course, with conventional annuity-based pensions this would not be an issue, as longevity risk is managed automatically and indeed the issue of sustainability of withdrawals is intrinsically linked to the defined benefit (DB) versus defined contribution (DC) pension debate.

There are a large number of so-called adaptive withdrawal methods in the literature which explicitly recognise the reality of changing and unpredictable investment returns, withdrawal amounts, and interest rates as new information unfolds through the withdrawal period, (see references in Spitzer et al. (2008), Suarez et al. (2015), Clare et al. (2017) and Waring and Siegel (2015)). A further development would be to consider optimal withdrawal rates based on an assumed utility function as in the treatment of longevity risk by Milevsky and Huang (2011). Here, we exclude the impact of inflation, in that all calculations are in inflation–adjusted (i.e., US CPI) terms, and optimisation of decision-making via utility maximisation.

In this paper we use the recent concept of Perfect Withdrawal Rates (PWR, see Suarez et al 2015, Clare et al, 2017) to assess appropriate withdrawal amounts year by year based on changing returns and (probably) in conversation with an adviser. As such the withdrawal strategy is definitely 'adaptive' and the focus here is on devising a new measure of success of a portfolio retirement strategy which reflects the aspirations of both retiree and adviser in their practical communications.

The PWR is the annual withdrawal rate over a pre-set horizon based on perfect foresight for a chosen asset allocation and is updated annually based on market history. In this paper we examine both constant and adaptive withdrawal approaches and introduce a new measure of success to gauge how well a withdrawal strategy performs *against a target withdrawal amount.* We suggest that this offers a very practical and intuitively appealing possible measure of success for the performance of portfolios in the decumulation context.

We begin by analysing the constant withdrawal '4%-rule' using UK annual equity returns data before extending the analysis to adaptive decision-making using the PWR approach and introducing a popular multi-asset portfolio. In each case we explore the practical use of the Minimum Acceptable Annual Withdrawal Rate (MAAW) approach to measuring the success of a decumulation strategy.

2. Alternative Approaches to Decumulation

i) Constant Withdrawal Methods: The 4% Rule

Perhaps the most basic method to drawdown a pension pot is to choose an annual withdrawal amount at the start of decumulation and then to stick with it rigidly irrespective of how much remains in the pot at any point in time. This has been the focus of much of the research in this area since Bengen (1994). If one chooses to adopt such a method then the only decision to be taken is what value should be the annual withdrawal amount to take: *this offers no longevity protection*, a key consideration in retirement calculations. Should this leave a residual sum, then it is consistent with having under-consumed for the years one is withdrawing over.

Figure 1 shows the historical 20-year withdrawal rates for a 100% investment in UK equities since 1900 from Barclays EGS (2012). These can be interpreted as Perfect Withdrawal Rates (PWR) in the sense of Suarez et al (2015) as they represent the constant rate of withdrawal that would exactly exhaust a pension pot over 20-years, (see Suarez et al, 2015, for a full description of this metric). We begin with this simple 100%-equity portfolio as we have a long-run of quality data. Throughout the paper, all returns quoted are real and are relative to the UK Retail Price Index. All values are in British Pounds.

The first point of note is the huge variation in the PWRs over the time frame in question. Within a 10-year starting period, the PWR ranged from less than 4% to over 16%. Remembering this is in *real* terms we note that the consequences of the randomness of an individual's retirement start date are quite remarkable. Such a wide variation in perfect withdrawal rates makes it very difficult to choose an appropriate amount to take without hindsight, and also makes a mockery of the 4% rule in terms of any discussion of under consumption. Withdraw too much money out and one will exhaust the pot before the retirement period is complete, take too little and one will end up with a significant balance at the conclusion.

Figure 1 also shows some withdrawal rate percentiles based on known completed 20-year periods at that point in time, e.g. at the start of 1960 one knew all the overlapping 20-year periods that commenced up to, and including, 1940. For the purposes of an example, we will assume that a retiree withdraws at the constant 25th percentile rate based upon what this was at the start of decumulation, which was £5,506 per annum.

Table 1 shows two different types of conclusion, with the left-hand side starting in 1971 and running out of money and the right-hand side, starting in 1981 and ending up with a balance of over five times the size of the initial amount. The left-hand side period was plagued by two very negative returns in 1973 and 1974 which would have decimated the investment pot. This does not recover to a level that could sustain the chosen withdrawal rate and eventually expires with insufficient money to complete a full set of payments at the start of 1988. The consequence is that there were a further two complete years unfunded after this, namely 1989 and 1990. On the right side of the table, the period benefits from returns in the early 1980s that were very high and this quickly leads to a big increase in the pot, even after making the constant withdrawals. The biggest loss absorbed is just over 15% in 1990 but this only makes a small dent, given the sums accumulated up to that point. Returns remain very strong in the late 1990s and the pot finishes the 20-year period in excess of £550,000, some five times the starting value. The 25th percentile PWR allows an annual withdrawal of £5,536; not too different from that in the left-hand column.

Clearly, in practice if the results in the left-hand example had actually happened, the investor would have begun *reducing* the withdrawal amount when faced with running out of money. Part of the contribution of this paper is to devise ways in which this stark choice can be avoided.

Figure 2 displays the final balances for each of the 20-year decumulation periods that commence from 1960 onwards. In the case where the balance is exhausted before completion, a red dot indicates how many entirely unfulfilled years remained, e.g. in our example from Table 1 this would be 2 years since 1988 had a partial withdrawal. Notice how there are a cluster of red dots around the late 1960s and early 1970s. These are the periods that felt the full effect of the substantial negative returns of 1973-74. Another couple of red dots appear in 1999 and 2000 where these periods suffered the dotcom collapse early on, and also the global financial crisis a few years later. To lessen the risk of a 'red dot' year in a particular 20 -year period using a constant withdrawal method, one has to *reduce the annual amount taken and simultaneously accept the possibility of a very large final balance.*

Estimating the future returns of an asset class in order to select an appropriate withdrawal rate is, however, not the only factor to consider. The order that the returns appear in, or *sequence risk*, can have a major bearing. Clare et al (2017) provide a discussion of this topic in earlier work. Table 2 shows our original example from the left-side of Table 1 but the right-side is now replaced with exactly the same set of returns and constant withdrawal rate as the left but the position of the large 1974 negative return and the large 1989 positive return have been switched. The compound return of both sides of the table thus remains the same. Despite the equal overall return, and the failure of the left-hand side, the right-side of the table completes the full twenty years of withdrawals and has a balance of £175,000 at the end. This encapsulates the force of sequence risk. Unless one invests in a product that generates a constant real return, there is no way of avoiding it. Clare et al (2017) offer some suggestions as to how one might mitigate this risk but typically, it revolves around choosing a lower volatility portfolio solution, or indeed a portfolio which is largely cash in the final few years.

ii) Adaptive Withdrawal Methods and the Minimum Acceptable Annual Withdrawal Rate (MAAW)

Thus far we have considered setting a withdrawal amount at the start of decumulation and then resolutely sticking with it, irrespective of the changes in the portfolio value. Intuitively, though, it feels that one should adapt to the changing circumstances one faces. If the pot suffers a big loss then withdrawals should reduce to try to make them last the whole retirement period. Conversely, if the pot grows substantially then one could deem it safe enough to extract somewhat more, annually. We henceforth refer to this as adaptive withdrawals. Further, we ask how we can assess the effectiveness of withdrawal strategies in terms of failing to meet desired annual withdrawal amounts: is it often or infrequent, 5% or 20% of the time? This could be a metric for establishing the degree of confidence we have in a particular strategy.

Table 3 shows our earlier example with decumulation commencing in 1971, but this time using an adaptive method. In the first year, we use the median 20-year PWR known at that point as the withdrawal amount. After one year we recalculate, again using only known information, but this time using the median *19-year* PWR. This process continues annually, each time using one year less on the PWR calculation, until decumulation has completed. At this point the final balance is precisely zero. This is the simplest adaptive decumulation rule you can imagine using the PWR which guarantees *not* running out of money. It is no surprise that the withdrawal percentage rises quickly as we approach the end of the 20 years, as the sum has to be exhausted at that point, i.e. one takes 100% of the sum at the start of the last year. However, of more interest is that the *withdrawal amount* is more variable from year to year which may be considered unsatisfactory from the point of the individual in practice where we might reasonably assume that individuals prefer a smooth path of spending (and income) over time.

One can observe how, in the years after the big losses in 1973-74, withdrawals diminish relative to the initial amount. This reflects adapting to having a smaller remaining balance. In the early 1980s there are a string of relatively high positive returns and this facilitates an increase in withdrawals once again.

Given that the adaptive method is always targeting a zero balance at the end of the prescribed decumulation period, the *risk moves away from having no money left to the allowable withdrawals being insufficient to meet one's annual living expense requirements.* For instance, the initial withdrawal of £7,150 per £100,000 of the investment pot might have been perfectly acceptable but by the start of 1975 this amount had fallen to just £2,295 (the median PWR). The volatility in the underlying equity portfolio returns thus manifests itself in the volatility in the allowable withdrawals, which in turn may well be not practical.

This volatility is a direct function of the volatility of the underlying portfolio choice, i.e., 100% equities. Nevertheless, this portfolio allows us to describe the essential mechanics of this process and our multi-asset combinations in the next section demonstrate more reasonable real-world volatility.

iii) Introducing Minimum Acceptable Amounts

A far more sensible, and indeed practical, approach following typical financial planning advice might well be to ask the question: what is the *minimum acceptable amount* I need each year from my investment pot to meet my needs? We will call this MAAW. This quantity could be viewed as a simple measure of the lower-bound for desired income from a behavioural approach to decision making.

To this end we suggest that the individual estimates what the minimum acceptable annual withdrawal (MAAW) is before commencing an adaptive decumulation path. This would be an amount that reflects the lowest yearly withdrawal than one needs in order to have a satisfactory amount to meet one's desired lifestyle requirements. If MAAW is set very low then it is likely to be easily achieved and one can consider the potential upside of various strategies.

Should MAAW be set unrealistically high then it will not be possible to construct a portfolio that can deliver the desired amounts. This could require remedial action in terms of, say, additional years working, to build up the pot still further whilst simultaneously lowering the number of decumulation years to be completed, the revision of one's lifestyle standard to accept a lower MAAW or some combination of both.

Figure 3 shows the success rates by year of decumulation commencement for levels of MAAW, between 4 and 7%, expressed as a percentage of the starting balance, using the median adaptive PWR approach. There are 20 possible withdrawals in each decumulation period and the total that equal or exceed the MAAW are expressed as a percentage, e.g. if the MAAW is set to

£5,000 and 18 withdrawals are greater than or equal to this, then the success rate would be equal to 90%. As one would anticipate, as MAAW increases so the probability of some annual failures does too. The 5% MAAW could arguably be considered a benchmark since if one invested the portfolio in a security which earned precisely a zero real return annually, this would be the constant withdrawal rate based on a 20-year decumulation period to a zero balance. It is interesting to note just how many periods there were that failed to allow for this amount to be taken given one would anticipate a positive real return from equities over an extended period. *The volatility of the asset class makes it very difficult to take something approaching a consistent withdrawal.*

Figure 4 displays the minimum annual withdrawal for each starting year. It is noticeable just how low these are compared to the neutral 5% MAAW level for a substantial proportion of the starting years. There is a big shift in the post-1974 starting points. This again highlights that the decumulation periods prior to this were blighted by the large 1973-74 negative returns.

Figure 5 reports the cumulative over and undershoot of each of the annual withdrawals in a 20-year period. If the MAAW is set to £5,000 and the median PWR gives rise to a withdrawal of £6,000 then that would be an overshoot of the target by £1,000. However, if the PWR only allows for a withdrawal of £4,000 then that is an undershoot of £1,000. All of the negatives are summed and shown as a red bar below the x-axis and all the positives summed and shown as a blue bar above the axis. The negative value is capped at minus £100,000, i.e. all 20 years have exactly zero withdrawals, whilst the positive value is unbounded. From this we can observe that in most cases one is able to take in excess of £100,000 of withdrawals from the portfolio, i.e. the blue bars are in excess of the red for most periods, but due to the volatility of the underlying strategy there are many times when one has to take less than £5,000 annually.

A legitimate tactic here would be to say that if the MAAW is not just the minimum but actually a satisfactory amount to extract annually then why doesn't one simply take this amount when allowed and use the excess as a buffer against times when suggested withdrawals are lower. Table 4 shows our example again but this time in any year when the suggested withdrawal (PWR × Balance) is greater than £5,000 only this fixed amount will be taken and the remainder left in the investment pot. If, however, the suggested withdrawal falls below £5,000 then the lesser amount will be taken, thus adhering to the adaptive principle of endeavouring to avoid running out of funds before decumulation is complete. As a result of following this strategy, the minimum withdrawal increases to £2,567, compared to £2,295 in Table 3; this remains a long way below the £5,000 target, though. There were 6 years when one was unable to withdraw the MAAW whereas this was 9 years in Table 3. The high volatility of the underlying portfolio is still too much to sustain the retirement strategy despite adopting a more conservative approach. One should also note that, as a result of not following the true adaptive path, there was also a residual balance of £37,800. Henceforth, we will stick to the *pure adaptive withdrawal* approach.

3. Introducing Multi-Asset Portfolios

i) Using 20-year strings to estimate the MAAW

We now introduce more realistic multi-asset portfolios whose returns primarily show reduced volatility compared with the equity-only returns examined thus far. We have also introduced the MAAW as an alternative approach to calibrating and assessing the effectiveness or otherwise of a sustainable/minimally acceptable, withdrawal policy. We have seen the problems caused by the more volatile equity-only portfolio in terms of driving volatile withdrawal amounts. And we have observed in earlier sections that one or more large losses can cause significant disruption to the process of otherwise relatively smooth withdrawal profiles. Having a 100% allocation to a volatile asset like UK equities thus appears undesirable. If one wanted to be entirely invested in equities then a World portfolio would be a more appropriate undertaking.? Further steps would include adding bonds, commodities and cash to the investment mix to try and dampen volatility further whilst still providing enough return to allow for acceptable withdrawals.

To make the example more concrete we will explore these ideas using the *Permanent Portfolio* popularised by Browne (1981) which is an equally market value-weighted combination of World equities (WEQ), UK government bonds (GILTS), gold (GOLD) and UK T-Bills (CASH). Browne suggests that it should be well suited to the prevailing economic conditions at any particular time. This is a lower downside-risk portfolio than the traditional 60-40 equity and bonds portfolio and originated from the volatile times in the early 1970's when large losses in domestic equities and gilts are offset by holdings of gold, a non-Sterling denominated asset. Our data runs from 1970 to 2019, all results are reported from the beginning of 1971. Equity indices throughout are gross (real) values from MSCI; gilts returns are derived from the FTSE Actuaries All Stocks Index from 1976 onwards and 20-year gilts prior to this date; gold returns are LBMA values and cash rates refer to 3-month UK Treasury Bills.

Table 5 provides some summary statistics on the four asset classes along with information on their MAAW success when held *individually*. WEQ and GOLD have similar volatility although the former has an average return nearly two percentage points higher. GILTS have approximately half the volatility of the riskiest assets but a return of only 2.54% in real terms whilst CASH only barely has a positive real return at 0.63% but volatility is also extremely low at 3.85%. For each asset we also report the MAAW success rate. This is initially shown as the annual success rate, i.e. the proportion of annual periods in which an amount greater than or equal to the MAAW percentage multiplied by the starting balance is achieved. We have 30 decumulation periods starting from 1971-2000 inclusive, each of 20 years, thus 600 annual periods for the annual MAAW success rate to be calculated over. At the bottom of the table we also report the full MAAW success rate. A full success is recorded only if all 20 annual periods in a decumulation path are greater than or equal to the chosen MAAW rate. The combination of the two statistics is useful in that MAAW failures tend to be clustered. For instance, looking back at Tables 3 and 4, notice the concentration of low withdrawals in the period 1975-77.

Unfortunately, given the shorter period of data, it is not possible to create point-in-time estimates for historical withdrawal rates that can then be used for forward-looking calculations. To this extent, we choose a method that hopefully gives some consistency across the asset classes. For each asset we calculate the geometric average return over the full period of data from 1971-2000. We then assume that this is the constant return in every year of the PWR calculation, e.g. in the case of GILTS the geometric return is 2.54% and we assume this is repeated in each of the 20 years to give a baseline withdrawal rate. This facilitates a much easier withdrawal calculation than doing a Monte Carlo simulation, for example. Whilst it would be ideal if the estimate did not come from data used in the subsequent withdrawal paths, the value is not truly fitted. In the actual withdrawal calculations, the return in 1971 only appears once in the very first decumulation string. By the same token, the 2019 return only appears once in the very last decumulation path. Each of these values carries the same weight in the geometric average as a return from 1992, for example, that appears in 20 different decumulation strings.

We observe that when the bar is set very low in terms of success at the 3% MAAW rate then CASH is the only asset that manages to achieve a perfect 100% score. Both WEQ and GILTS get fairly close whilst GOLD only manages a 77.7% annual score and just 43.3% in full periods. As one increases the MAAW threshold so the probability of failure increases across all asset classes. At the 5% level no single asset class has a success rate above 90% and GOLD is below half. When the desired MAAW gets markedly higher, at the 7% level, one is forced to take on more risk in the shape of WEQ to increase the chance of success. None of the other assets manage to complete a single full decumulation period that delivers this level or higher.

Figure 6 shows thumbnail graphs of the withdrawal profiles for each of the four assets over time with the axes all set to the same scale to aid comparison. Each year in which a decumulation path commenced has a value plotted for the maximum, the 75th percentile, the median, the 25th percentile and the minimum withdrawal. Firstly, it is noticeable how the band for WEQ and GOLD is much wider than GILTS and CASH, reflecting the higher volatility of the former pair. The big spike in the withdrawals for WEQ starting in 1975 is similar to that observed in Figure 1 for UK equities. Of particular interest, however, is the shape of the various channels. WEQ and GILTS both have some of their lowest withdrawal profiles near the start of the period and also at the end. Contrast that with GOLD where the graph is more 'bowl' shaped. As we alluded to earlier, the high inflation years at the start of decumulation in the early 1970s were bad for stocks and bonds but very favourable for commodities. The period in the middle saw disinflation takeover and the roles were reversed. Real returns were generally higher on CASH during this period too. GOLD once again picked up in the 2000's when equities encountered multiple bear markets and interest rates were historically low for long periods. The differing withdrawal profiles of the various assets suggest that diversified multi-asset portfolios may well offer some improvement on single asset classes.

Table 6 reports summary statistics for four portfolios comprised of multiple assets. We have an equity-tilted 50% WEQ, 30% GILTS, 20% GOLD (50-30-20 hereafter), a bond-tilted 30% WEQ, 50% GILTS, 20% GOLD (30-50-20 hereafter), an equal-weight portfolio of WEQ, GILTS and GOLD (EW3 hereafter) and an equal-weight of all four assets (EW4 hereafter). As one might expect, the portfolio with most equity has the both the highest return and volatility whilst the one with CASH has the lowest of each. Interestingly EW3 has a higher return *and* lower volatility than 30-50-20. Looking at the MAAW stats, we find that all four multi-asset portfolios have a 100% success rate at the 4% level and virtually the same annually at the 5% level. This is markedly higher than for the comparable results for the individual assets in Table 5. All multi-assets still achieve over 90% annual success at the 6% MAAW level although this ranges between approximately 60-80% for full period success. When one reaches a 7% MAAW level, there is only a relatively small chance of achieving all 20 years above this withdrawal rate. We stop reporting results at this point since it is getting close to the initial annual withdrawal. It clearly makes little sense to set a MAAW objective at level such that the very first amount drawn will fail to meet the target. If this happens one needs to reassess the decumulation plan.

Figure 7 shows thumbnail graphs for each of the four multi-asset strategies in Table 6. For ease of comparison with the individual asset graphs in Figure 6 we have kept the scaling of the axes the same. It is very noticeable how these portfolios demonstrate less variable withdrawal rates compared to the individual risky assets in Figure 6. There is still something of a trough followed by a peak in the early 1970s but it is not nearly as pronounced as with WEQ and GILTS individually. This highlights the benefit of having the allocation to GOLD which outperformed during the inflationary period when WEQ and GILTS suffered. Both EW3 and EW4 maintain withdrawals largely within a channel that ranges from £5,000 to £10,000. We believe this consistency is beneficial in the context of retirement planning.

A point of note from Table 6 is that, despite the superior risk-reward profile of EW3, it underperforms 30-50-20 on the MAAW statistics at the 6% and 7% levels. We ascribe this to the compound return and volatility calculations applying the same weighting to each annual return between 1971-2019 but this is not true in the case of the PWR/MAAW computations. Some returns are going to appear more frequently in the latter than others. For example, the 1971 return only appears in one 20-year decumulation string, i.e. the very first return in the decumulation path starting in 1971. The same is true for the 2019 return which only appears as the very last return in the 2000-commencing string (and has no impact when decumulating to a zero balance). Other returns, however, are going to appear in a full 20 years of individual return strings, e.g. 1990 returns are the final return in the 1971-commencing path and appear in every subsequent one until they become the first in their own commencing string.

To illustrate the effect of this unequal usage of returns, Table 7 shows those returns that appear in twenty strings (from 1990 to 2000 inclusive) and compares their compound return with that of the whole period. Looking first at the individual assets, WEQ and CASH both return over 3% higher than the entire period during that time frame whilst GILTS achieved nearly 4.7% more. By contrast, GOLD returned -5.9% compared to +3.3% overall for over a 9% swing. This helps to explain the differences observed between 30-50-20 and EW3 in Table 6. Over the whole period the latter had a higher return of nearly 0.5% versus the former but amongst the most used returns it was more than 1.6% lower. This highlights a weakness of the approach whereby one only uses actual strings of data to back test decumulation strategies. There is a sound case for combining the observations from the withdrawals with the portfolio statistics over the full period when making asset allocation decisions in real time.

ii) Introducing Monte Carlo calculations as an alternative

An alternative method to analysing the performance of portfolios is to use Monte Carlo simulations whereby each annual return has an equal chance of being drawn in any 20-year sequence. Figure 8 shows the annual MAAW success rate for each of the four multi-asset portfolios based on 50,000 simulations. From this we observe that, at the lowest MAAW rates, EW4 offers the greatest chance of success. Note that this assessment is independent of whether the portfolio fails at the MAAW level, i.e. how far it misses the MAAW target by. When MAAW increases to about 5.5% the EW3 and EW4 lines cross and the former thereafter has the highest success rate. This persists until around 6.8% when the 50-30-20 portfolio crosses over and becomes dominant. At this high MAAW level one needs more equity to have any chance of success. The pattern is very similar in Figure 9 but this time full MAAW success rates are shown, albeit with lower associated probabilities than the annual values. One could thus use this as a method for selecting an asset allocation. ***The choice could be made on the basis that one selects the asset allocation which offers the highest chance of success for a given MAAW level.*** Should two or more asset classes each offer a 100% chance of achieving the target then the allocation which satisfies the highest MAAW value whilst still maintaining a 100% record is adopted.

A point of note from Figure 8 is that the success rate at the 5% level for EW3 and EW4 is around 75-80%, whereas in Table 6 these were perfect at 100%. Alongside our 50,000 EW3 simulations we also calculate the compound return of each string of 20-years. We have plotted the frequency of these observations in Figure 10. The vertical dashed lines added show the highest and lowest 20-year compound returns from the actual run of 1971-2019 data. It becomes clear from this that the Monte Carlo simulation contains values way outside of the boundaries of return sequences from the past 50 years. The question thus becomes, how realistic are these occurrences? There is clearly a probability of returns happening outside the range of the actual data but it is difficult to know if the simulated 5% chance of getting a 20-year EW3 return less than 1.35% is a sensible estimate. For instance, looking back at the sequence of returns in Table 1, one might ask if it was random that the triple digit positive value in 1975 was preceded by two large negative returns of -32% and -59% as the Monte Carlo simulation would imply?

Ideally, one would like a large number of 20-year, independent, return strings but that is not an option. Both methods we have demonstrated have positive and negative aspects to them. The actual data has no issues regarding its composition but there are relatively few data points and many are overlapping. By contrast, the Monte Carlo method has huge numbers of strings of data but there are legitimate questions has to how well they actually represent the true probability of future returns.

There is an ongoing debate over the use of historic strings of returns versus full Monte Carlo in this type of analysis though it is perhaps not as prominent in the retirement literature as it should be. Basically, MC analysis overstates tail risk relative to the actual experience of returns in practice and some researchers suggest advisers should use actual historic returns sequences in retirement projections (see Derek Tharp, 'Fat Tails in Monte Carlo Analysis vs Safe Withdrawal Rates', www.kitces.com, July 5th, 2017). Essentially, this latter approach is reaffirming the importance of sequences of returns and implicitly rejecting those annual returns are indeed independent.

4. Decumulating to a Residual Balance

In all of our calculations and examples thus far we have assumed that at the end of twenty years, decumulation is complete and the aim is for a zero balance. Uncertain longevity requires consideration of strategies to make a pension pot last longer than a fixed time frame. Clare et al (2021) discuss this in detail but one of the options is to aim to decumulate the investment pot to a desired non-zero level after, say 20 years, and then purchase an annuity which transfers the longevity risk elsewhere. We refer to this as a *delayed annuity*. Of course, if a market for deferred annuities exists then this is another option (see Chen et al, 2021). The perfect withdrawal calculation can make allowances for leaving this residual balance although it comes, not unexpectedly, with the caveat that the amounts taken during the decumulation period will be lower than if one was decumulating to a completely exhausted final balance. Now the pot of wealth has to last a lifetime, not just 20 years.

Table 8 shows an example of an EW3 portfolio decumulated to zero and the comparable withdrawals when a residual balance of £30,000 is targeted instead (right-hand columns). We have selected the PWR to be the median value. Firstly, we note that the initial withdrawal is £7,608 when there is full decumulation compared to only £6,738 with the residual target. The greater the desired residual, the lower this initial amount will be. The withdrawals remain lower throughout the 20-year period with a mean of £8,900 for the zero-balance version and £8,200 for the residual target. In the very last row one can observe the final total of zero pounds remaining in the left-hand example whilst the right-hand balance ends with a value of £24,673. The latter is some distance below the targeted amount of £30,000 and can be attributed to the low return of -13.7% in the final year, this was the second lowest in the entire string. We will revisit this issue of hitting the residual target later on in the paper.

Table 9 reports the MAAW statistics for the EW3 portfolio but this time using a range of targeted residuals from 10% to 40% of the initial balance. To recap from Table 6, the success rate for this portfolio with a zero balance was 100% for a MAAW target of 5%. We now observe that at a lowly 2% MAAW rate there is less than complete success when the residual is 30% or higher. At a 4% rate, only the 10% residual achieves 100% success whilst the 40% residual has under 50% full period success. As the MAAW rate is ratcheted up to 5% none of the portfolios remain perfect and by the time it has reached 60%, the chance of achieving a complete 20 years of success is approximately one-third or lower for all portfolios. The comparable value from Table 6 was 63%. *We conclude from this that one needs to lower withdrawal ambitions, for any given portfolio, the greater the residual balance that is targeted.*

Figure 11 displays thumbnail graphs for each of the four residual categories. As before, we have fixed the scale on the charts for consistency with the maximum set to £20,000 and £5,000 intervals shown on the y-axis. Again, for reference, the EW3 portfolio from Figure 7 remained for the most part contained with a £5,000 to £10,000 withdrawal range and never fell below the lower bound. Looking at the four charts we note that as the residual target increases, so does *the volatility of the withdrawal channel.* The peaks and troughs in the early 1970s starting points become more pronounced along with other periods now falling outside of the £5-10,000 range. Of particular interest is the minimum withdrawal line as this reflects failures in the full MAAW success when it dips below a specified level. In the bottom-right graph, the 40% residual level, the minimum withdrawal actually gets below zero at one point, i.e. there is a requirement from the PWR calculation to pay money in to the pot rather than take out. Clearly this not sustainable for a retirement strategy and thus one has to reflect on whether the target is too ambitious relative to the size of the initial investment pot.

When one is decumulating to a residual balance, the investment pot can be thought of as two components. The first is the withdrawal component from which the annual payments are taken and the second is the residual component from which the delayed annuity can be purchased. At the start of decumulation the withdrawal component is typically fairly large compared to the residual and this is able to absorb any losses from the underlying portfolio thus keeping the latter component intact. As the process is played out, though, the withdrawal component becomes smaller whilst the residual remains the same. Figure 12 provides an illustration of this, whilst one can observe it taking place numerically in the example from Table 8. The situation thus becomes one akin to trading on margin, or *pseudo leverage* as we refer to it. At any point in time both the withdrawal component and residual component are invested but one wishes to avoid losses being incurred on the latter before the full 20 years is complete. Towards the end there is only a thin layer of withdrawal component to protect the residual from being impacted, thus being similar in nature to say owning a futures contract where only 10% of the full value is deposited and should this be lost a margin call will be forthcoming from the broker. It is this relationship that leads to the higher volatility of cash flows observed in Figure 11. If returns are negative near the end of decumulation then the last withdrawals have the potential to be very small or even require additional payments to be made into the investment pot. ***The reverse can lead to substantial final withdrawals. In effect there is sequence risk now at both the start and end of decumulation***, the former has a big effect on the overall amount of withdrawals from a strategy whilst the latter has only a minor effect on total cash flows but can have a large impact on a small number of annual payments.

Earlier we noted that in our example from Table 8, the final year saw a relatively large negative return. This resulted in the residual value failing to meet the target of £30,000 by some distance. As a consequence, one would have only been able to buy a smaller amount of delayed annuity and thus living standards for the future would be impaired. To this extent it is worth considering whether there are strategies available that can offset the increasing volatility towards the end of a residual-targeting decumulation path.

5. Scaling PWRs to Manage Withdrawals

One approach is to try to increase the buffer over the residual target by withdrawing at a lower rate than recommended by the PWR calculations, or *withdrawal scaling* as we henceforth refer to it. This results in more money being left towards the end of decumulation to hopefully better absorb any large losses. The flipside of this is that one has to be willing to accept lower withdrawals at the front of the strategy. Table 10 shows an example using the EW3 portfolio, again with a 1971 start date, but this time withdrawals are only taken at 80% of the PWR-calculated value. The initial effect is for the amount taken in Year 1 to be £5,390 versus £6,738 using the full PWR rate (see example in Table 8). Withdrawals continue to be lower in pound amounts until the start of 1982 when the scaled amount is £6,921 versus £6,850 for the unscaled method. They remain higher in each year thereafter. ***By taking a lower amount earlier on in the decumulation path it allows a larger proportion of the pot to compound returns and eventually reach a point where the smaller scaled withdrawal rate is applied to a sufficiently bigger pot such that the pound amount exceeds that of the unscaled drawdown method.*** When one looks at the final residual balance, it amounts to £28,100 which is still a little below the target but a considerable improvement on the unscaled balance of £24,700.

Figure 13 displays the decumulation profile across all years for the 80% withdrawal-scaled method. The minimum withdrawal now tends to lie just below the £5,000 level but volatility is relatively small compared to the equivalent chart with a 30% residual shown in Figure 11. Most of the volatility now lies in the maximum withdrawal line. This is a result of having a higher balance near the end of decumulation than in the unscaled version. If the final years have negative returns then there are sufficient funds mostly available to absorb the losses. If, however, the final years are large positive returns then the withdrawal component of the pot can dramatically increase due to the inherent pseudo leverage discussed earlier. It should be noted, however, that the total amount withdrawn from a decumulation strategy is not necessarily a good tool for making comparisons. For instance, a strategy which took no withdrawals for 19 years followed by one which was the entire balance in the final year would almost certainly result in a very high overall total withdrawal due to the compounding effect in the preceding years. It would be of little use as a decumulation method, though, given it offered no regular cash flows to a retiree.

Finally, Figure 14 reports the residual balances for each of the starting years in our data period. The dashed horizontal line represents the £30,000 target based on the initial residual value. From this we can observe that the majority of the decumulation paths exceed their stated ambition and, of those that fail, they are by relatively modest amounts. Indeed, the 1971 starting year is actually the worst of all the available data. In terms of MAAW rates, at the 5% level the 80% withdrawal scaling has a 90.5% annual success and 30% full success. Comparable figures without scaling are 92% and 40%, respectively. At the 4% MAAW level, however, there is almost complete success with only one annual period out of the six hundred available falling below the target rate. This is an improvement on the unscaled withdrawals used in Table 9.

6. Conclusion

In summary, we have demonstrated how one can go from an initial extremely risky approach of taking a fixed percentage from a pension fund fully invested in UK equities to a diversified, hybrid withdrawal strategy that seeks to mitigate a number of the risks associated with decumulation. We have used a multi asset portfolio rather than only UK equities to diversify some of the variance away. It was found that a strategy of only asset allocating between stocks and bonds could lead to a high level of sequence risk in periods of significant inflation. The addition of gold to underlying portfolios was extremely useful in this regard as it provided high returns during periods when the other assets suffered, even though there were other extended time frames where it proved a drag on returns. We observed how decumulating to a residual balance increased the volatility of the final cash flows including the residual itself. Adopting a conservative approach to decumulation by scaling down the size of cash flows below that suggested by perfect withdrawal calculations helped to improve the success of achieving minimum acceptable annual withdrawal targets.

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Table 1

Examples of Two Different 20-Year Decumulation Periods Starting in 1971 and 1981, using 25th Percentile Constant Withdrawal Rates

Year	Return	Start	WD	End	Year	Return	Start	WD	End
1971	27.8	100,000	5,506	120,747	1981	0.4	100,000	5,536	94,850
1972	5.0	120,747	5,506	121,024	1982	22.1	94,850	5,536	109,045
1973	-32.4	121,024	5,506	78,080	1983	24.1	109,045	5,536	128,484
1974	-59.0	78,080	5,506	29,747	1984	26.3	128,484	5,536	155,299
1975	100.7	29,747	5,506	48,649	1985	16.4	155,299	5,536	174,311
1976	-9.6	48,649	5,506	38,983	1986	19.9	174,311	5,536	202,304
1977	26.2	38,983	5,506	42,256	1987	2.6	202,304	5,536	201,947
1978	-1.0	42,256	5,506	36,393	1988	2.7	201,947	5,536	201,689
1979	-4.9	36,393	5,506	29,387	1989	26.8	201,689	5,536	248,777
1980	14.7	29,387	5,506	27,403	1990	-15.6	248,777	5,536	205,216
1981	0.4	27,403	5,506	21,987	1991	14.7	205,216	5,536	229,060
1982	22.1	21,987	5,506	20,122	1992	15.7	229,060	5,536	258,719
1983	24.1	20,122	5,506	18,143	1993	25.0	258,719	5,536	316,478
1984	26.3	18,143	5,506	15,963	1994	-9.6	316,478	5,536	281,133
1985	16.4	15,963	5,506	12,171	1995	18.4	281,133	5,536	326,280
1986	19.9	12,171	5,506	7,990	1996	12.8	326,280	5,536	361,893
1987	2.6	7,990	5,506	2,550	1997	23.1	361,893	5,536	438,576
1988	2.7	2,550	2,550	0	1998	13.4	438,576	5,536	490,979
1989	26.8	0	0	0	1999	14.1	490,979	5,536	553,737
1990	-15.6	0	0	0	2000	-7.3	553,737	5,536	508,374

Table 2

An Example of Sequence Risk

Left hand side shows actual experience. The right-side shows exactly the same set of returns and constant withdrawal rate as the left but the position of the large 1974 negative return and the large 1989 positive return have been switched. The compound return of both sides of the table thus remains the same.

Year	Return	Start	WD	End	Year	Return	Start	WD	End
1971	27.8	100,000	5,506	120,747	1971	27.8	100,000	5,506	120,747
1972	5.0	120,747	5,506	121,024	1972	5.0	120,747	5,506	121,024
1973	-32.4	121,024	5,506	78,080	1973	-32.4	121,024	5,506	78,080
1974	-59.0	78,080	5,506	29,747	1989	26.8	78,080	5,506	92,045
1975	100.7	29,747	5,506	48,649	1975	100.7	92,045	5,506	173,669
1976	-9.6	48,649	5,506	38,983	1976	-9.6	173,669	5,506	151,945
1977	26.2	38,983	5,506	42,256	1977	26.2	151,945	5,506	184,843
1978	-1.0	42,256	5,506	36,393	1978	-1.0	184,843	5,506	177,593
1979	-4.9	36,393	5,506	29,387	1979	-4.9	177,593	5,506	163,727
1980	14.7	29,387	5,506	27,403	1980	14.7	163,727	5,506	181,552
1981	0.4	27,403	5,506	21,987	1981	0.4	181,552	5,506	176,766
1982	22.1	21,987	5,506	20,122	1982	22.1	176,766	5,506	209,094
1983	24.1	20,122	5,506	18,143	1983	24.1	209,094	5,506	252,711
1984	26.3	18,143	5,506	15,963	1984	26.3	252,711	5,506	312,253
1985	16.4	15,963	5,506	12,171	1985	16.4	312,253	5,506	357,027
1986	19.9	12,171	5,506	7,990	1986	19.9	357,027	5,506	421,353
1987	2.6	7,990	5,506	2,550	1987	2.6	421,353	5,506	426,793
1988	2.7	2,550	2,550	0	1988	2.7	426,793	5,506	432,608
1989	26.8	0	0	0	1974	-59.0	432,608	5,506	175,065
1990	-15.6	0	0	0	1990	-15.6	175,065	5,506	143,052

Table 3						
Adaptive Withdrawal Rates at the 50th Percentile for Decumulation using 100% UK Equity						
Calendar Year	Years Remaining	Return (%)	Withdrawal Rate (%)	Start (£)	Withdrawal (£)	End (£)
1971	20	27.8	7.15	100,000	7,150	118,645
1972	19	5.0	7.35	118,645	8,718	115,444
1973	18	-32.4	7.60	115,444	8,772	72,101
1974	17	-59.0	7.96	72,101	5,741	27,200
1975	16	100.7	8.44	27,200	2,295	49,980
1976	15	-9.6	8.74	49,980	4,370	41,211
1977	14	26.2	9.19	41,211	3,789	47,236
1978	13	-1.0	9.86	47,236	4,659	42,163
1979	12	-4.9	10.59	42,163	4,463	35,868
1980	11	14.7	10.99	35,868	3,942	36,634
1981	10	0.4	11.88	36,634	4,352	32,414
1982	9	22.1	13.06	32,414	4,233	34,407
1983	8	24.1	14.24	34,407	4,900	36,626
1984	7	26.3	16.31	36,626	5,974	38,717
1985	6	16.4	18.35	38,717	7,105	36,794
1986	5	19.9	21.59	36,794	7,943	34,582
1987	4	2.6	26.73	34,582	9,244	26,005
1988	3	2.7	34.74	26,005	9,034	17,427
1989	2	26.8	51.05	17,427	8,897	10,819
1990	1	-15.6	100.00	10,819	10,819	0

Table 4

Constant £5,000 MAAW Subject to Adaptive PWR Constraint at the 50th Percentile for Decumulation using 100% UK Equity

Calendar Year	Years Remaining	Return (%)	Withdrawal Rate (%)	Start (£)	Withdrawal (£)	End (£)
1971	20	27.8	7.15	100,000	5,000	121,393
1972	19	5.0	7.35	121,393	5,000	122,233
1973	18	-32.4	7.60	122,233	5,000	79,239
1974	17	-59.0	7.96	79,239	5,000	30,430
1975	16	100.7	8.44	30,430	2,567	55,915
1976	15	-9.6	8.74	55,915	4,889	46,105
1977	14	26.2	9.19	46,105	4,239	52,846
1978	13	-1.0	9.86	52,846	5,000	47,380
1979	12	-4.9	10.59	47,380	5,000	40,321
1980	11	14.7	10.99	40,321	4,432	41,182
1981	10	0.4	11.88	41,182	4,892	36,438
1982	9	22.1	13.06	36,438	4,758	38,678
1983	8	24.1	14.24	38,678	5,000	41,804
1984	7	26.3	16.31	41,804	5,000	46,489
1985	6	16.4	18.35	46,489	5,000	48,289
1986	5	19.9	21.59	48,289	5,000	51,889
1987	4	2.6	26.73	51,889	5,000	48,123
1988	3	2.7	34.74	48,123	5,000	44,282
1989	2	26.8	51.05	44,282	5,000	49,820
1990	1	-15.6	100.00	49,820	5,000	37,813

Table 5				
Summary Portfolio and MAAW Statistics for Four Asset Classes				
	WEQ	GILTS	GOLD	CASH
Annual Compound Return (%)	5.15	2.54	3.27	0.63
Annual Volatility (%)	22.25	11.49	22.24	3.85
Annual MAAW Success (3%)	99.50	96.83	77.67	100.00
Annual MAAW Success (4%)	95.00	91.50	61.50	94.83
Annual MAAW Success (5%)	87.83	88.33	49.50	84.17
Annual MAAW Success (6%)	81.33	83.50	41.67	53.50
Annual MAAW Success (7%)	73.83	61.33	27.17	30.17
Full MAAW Success (3%)	90.00	90.00	43.33	100.00
Full MAAW Success (4%)	80.00	86.67	23.33	86.67
Full MAAW Success (5%)	70.00	80.00	16.67	66.67
Full MAAW Success (6%)	56.67	53.33	13.33	0.00
Full MAAW Success (7%)	43.33	0.00	0.00	0.00

Table 6				
Summary Portfolio and MAAW Statistics for Multi-Asset Portfolios				
	50-30-20	30-50-20	EW3	EW4
Annual Compound Return (%)	5.11	4.47	4.94	3.95
Annual Volatility (%)	12.18	10.02	9.79	7.38
Annual MAAW Success (3%)	100.00	100.00	100.00	100.00
Annual MAAW Success (4%)	100.00	100.00	100.00	100.00
Annual MAAW Success (5%)	99.33	99.00	100.00	100.00
Annual MAAW Success (6%)	94.67	95.50	93.83	96.67
Annual MAAW Success (7%)	75.33	74.50	64.50	62.50
Full MAAW Success (3%)	100.00	100.00	100.00	100.00
Full MAAW Success (4%)	100.00	100.00	100.00	100.00
Full MAAW Success (5%)	86.67	93.33	100.00	100.00
Full MAAW Success (6%)	73.33	80.00	63.33	73.33
Full MAAW Success (7%)	26.67	20.00	16.67	10.00

Table 7

Returns During Years that Appear in Twenty Decumulation Strings versus Whole Period Returns

Year	WEQ	GILTS	GOLD	CASH	50-30-20	30-50-20	EW3	EW4
1990	-15.63	0.22	-25.67	4.41	-12.88	-9.71	-13.69	-9.17
1991	14.71	11.16	-10.24	6.27	8.66	7.95	5.21	5.47
1992	15.75	15.62	13.43	6.35	15.24	15.22	14.93	12.79
1993	25.00	18.63	18.40	3.27	21.77	20.50	20.68	16.33
1994	-9.59	-8.89	-10.03	2.18	-9.47	-9.33	-9.50	-6.58
1995	18.39	12.80	-1.89	3.03	12.66	11.54	9.76	8.08
1996	12.83	4.72	-14.28	3.27	4.97	3.35	1.09	1.63
1997	23.07	9.92	-22.60	2.71	9.99	7.36	3.46	3.28
1998	13.38	15.70	-4.33	4.07	10.54	11.00	8.25	7.21
1999	14.07	-2.60	2.51	3.24	6.76	3.42	4.66	4.30
2000	-7.27	5.64	-0.34	2.79	-2.01	0.57	-0.65	0.21
Annual Compound Return (%)	8.67	7.22	-5.89	3.77	5.54	5.24	3.58	3.71
Annual Volatility (%)	13.76	8.60	13.61	1.39	10.41	9.38	9.88	7.51
Full Period								
Annual Compound Return (%)	5.15	2.54	3.27	0.63	5.11	4.47	4.94	3.95
Annual Volatility (%)	22.25	11.49	22.24	3.85	12.18	10.02	9.79	7.38

Table 8

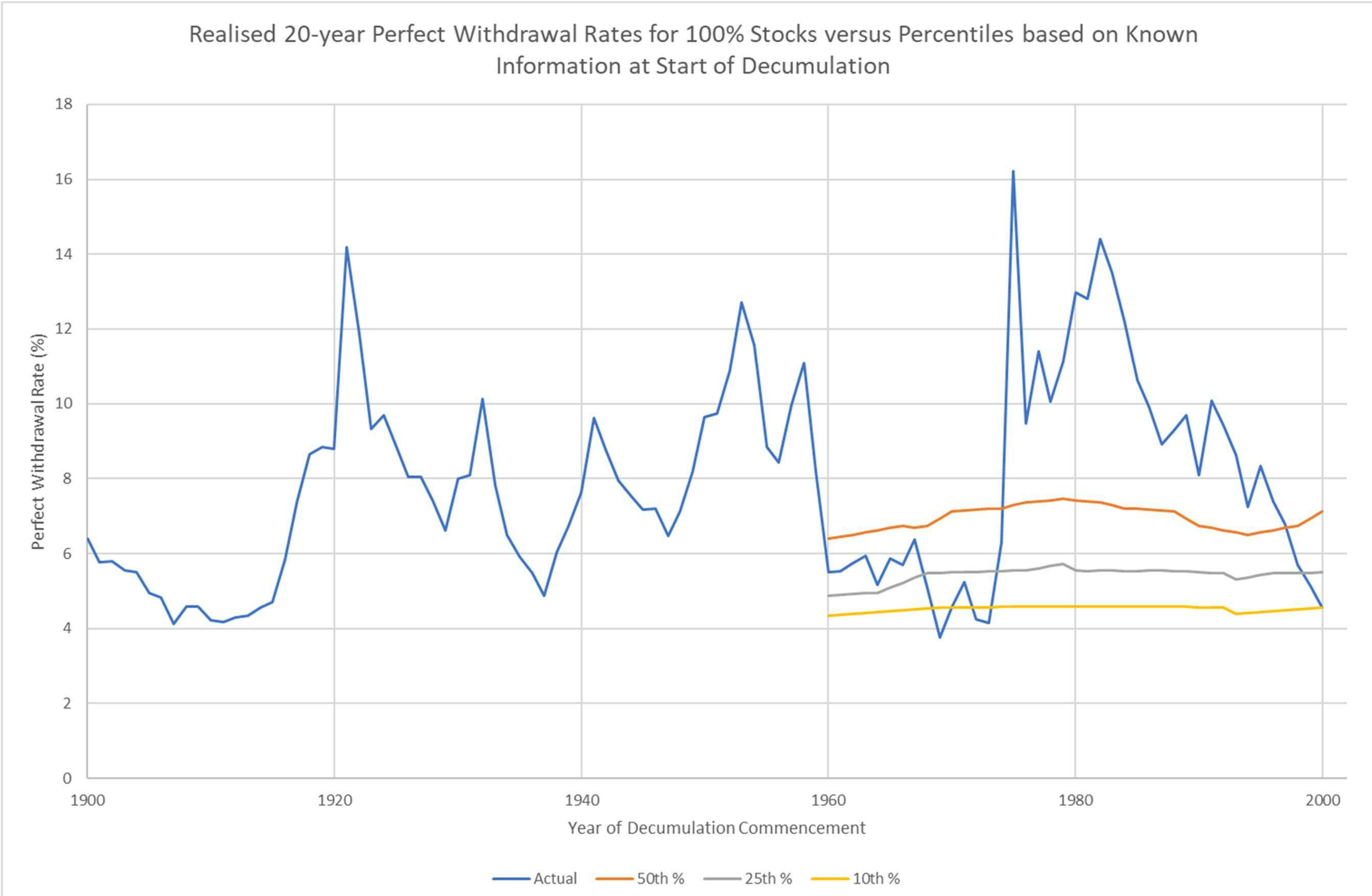
Examples of Decumulation using EW3 Portfolio with and without a Residual Balance Target

		No Residual					£30,000 Residual Target				
Year	Returns (%)	Residual (%)	Withdrawal Rate (%)	Start (£)	Withdrawal (£)	End (£)	Residual (%)	Withdrawal Rate (%)	Start (£)	Withdrawal (£)	End (£)
1971	17.3	0.00	7.61	100,000	7,608	108,392	30.00	6.74	100,000	6,738	109,413
1972	12.9	0.00	7.85	108,392	8,505	112,795	27.42	6.99	109,413	7,643	114,921
1973	1.4	0.00	8.11	112,795	9,152	105,135	26.10	7.22	114,921	8,303	108,153
1974	-18.8	0.00	8.41	105,135	8,847	78,138	27.74	7.39	108,153	7,988	81,284
1975	27.0	0.00	8.76	78,138	6,841	90,556	36.91	7.26	81,284	5,902	95,743
1976	-5.2	0.00	9.14	90,556	8,280	78,020	31.33	7.75	95,743	7,423	83,751
1977	15.0	0.00	9.59	78,020	7,482	81,122	35.82	7.84	83,751	6,567	88,766
1978	3.0	0.00	10.11	81,122	8,200	75,115	33.80	8.28	88,766	7,352	83,862
1979	20.5	0.00	10.72	75,115	8,049	80,817	35.77	8.57	83,862	7,184	92,399
1980	3.9	0.00	11.44	80,817	9,242	74,386	32.47	9.25	92,399	8,548	87,145
1981	-10.2	0.00	12.30	74,386	9,153	58,575	34.43	9.69	87,145	8,444	70,669
1982	28.1	0.00	13.37	58,575	7,832	64,983	42.45	9.69	70,669	6,850	81,728
1983	7.0	0.00	14.71	64,983	9,558	59,321	36.71	11.04	81,728	9,020	77,818
1984	8.8	0.00	16.43	59,321	9,748	53,926	38.55	11.91	77,818	9,270	74,567
1985	1.1	0.00	18.74	53,926	10,105	44,315	40.23	13.09	74,567	9,763	65,534
1986	13.3	0.00	21.97	44,315	9,738	39,179	45.78	14.07	65,534	9,220	63,809
1987	2.9	0.00	26.84	39,179	10,514	29,486	47.02	16.43	63,809	10,485	54,851
1988	-5.0	0.00	34.95	29,486	10,306	18,217	54.69	18.41	54,851	10,098	42,505
1989	9.2	0.00	51.21	18,217	9,328	9,710	70.58	18.39	42,505	7,815	37,896
1990	-13.7	0.00	100.00	9,710	9,710	0	79.16	24.56	37,896	9,308	24,673

Table 9				
MAAW Statistics for EW3 Portfolios with Varying Residual Balances				
	Residual (%)			
	10	20	30	40
Annual MAAW Success (2%)	100.00	100.00	99.67	98.67
Annual MAAW Success (3%)	100.00	99.83	98.83	97.50
Annual MAAW Success (4%)	100.00	98.67	96.67	94.67
Annual MAAW Success (5%)	98.00	94.67	92.00	85.83
Annual MAAW Success (6%)	86.33	77.83	67.17	59.50
Full MAAW Success (2%)	100.00	100.00	93.33	73.33
Full MAAW Success (3%)	100.00	96.67	76.67	63.33
Full MAAW Success (4%)	100.00	73.33	63.33	40.00
Full MAAW Success (5%)	80.00	50.00	40.00	33.33
Full MAAW Success (6%)	33.67	23.33	13.33	6.67

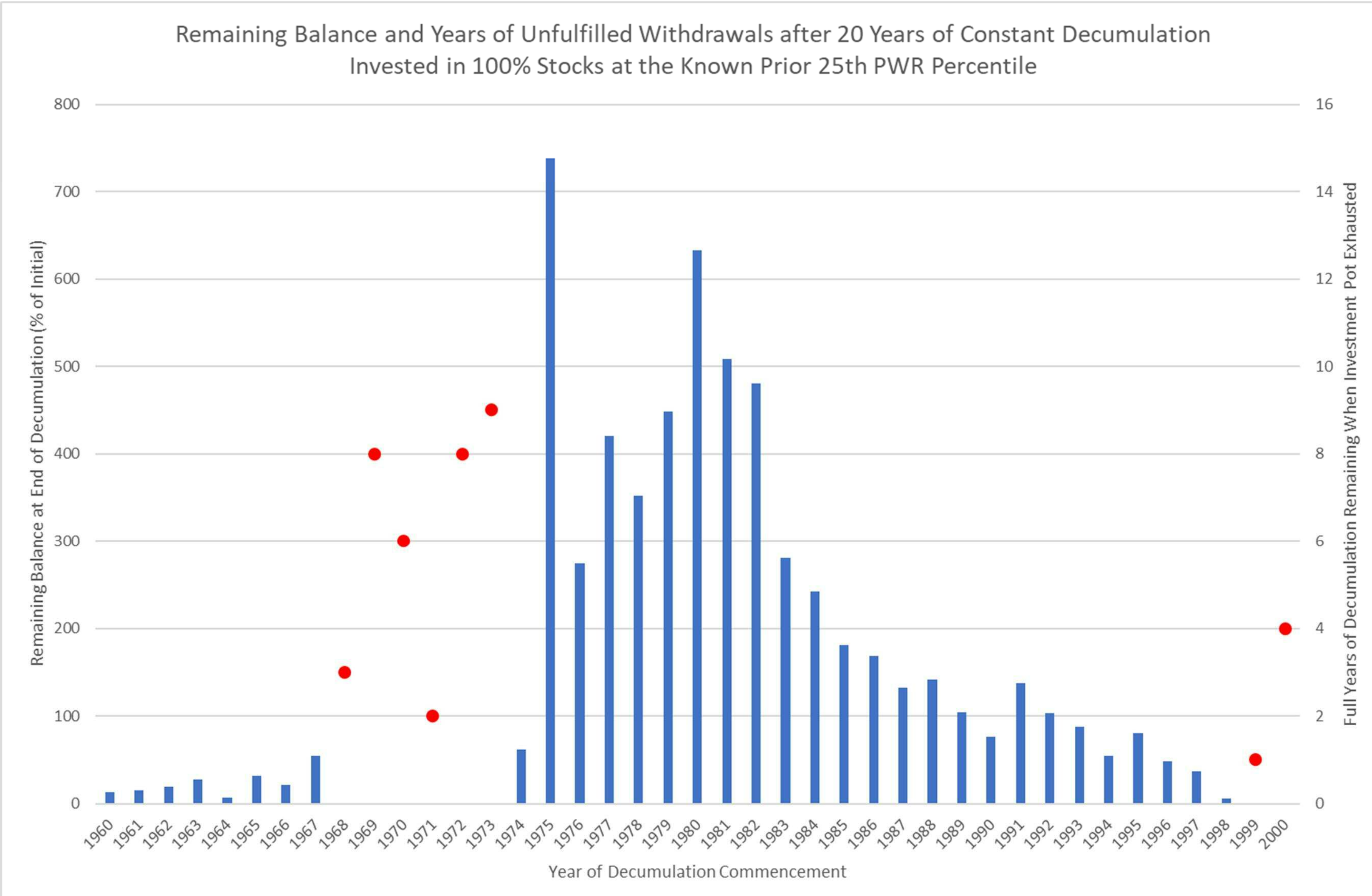
Table 10						
Adaptive Decumulation Example with an EW3 Portfolio to a 30% Residual Target Balance using 80% of Recommended PWR Withdrawals						
Calendar Year	Return (%)	Residual (%)	80% Withdrawal Rate (%)	Start (£)	Withdrawal (£)	End (£)
1971	17.3	30.00	5.39	100,000	5,390	110,993
1972	12.9	27.03	5.60	110,993	6,214	118,320
1973	1.4	25.35	5.80	118,320	6,863	113,062
1974	-18.8	26.53	5.94	113,062	6,721	86,295
1975	27.0	34.76	5.88	86,295	5,073	103,162
1976	-5.2	29.08	6.28	103,162	6,481	91,680
1977	15.0	32.72	6.39	91,680	5,862	98,695
1978	3.0	30.40	6.77	98,695	6,685	94,777
1979	20.5	31.65	7.05	94,777	6,683	106,157
1980	3.9	28.26	7.63	106,157	8,097	101,911
1981	-10.2	29.44	8.05	101,911	8,209	84,139
1982	28.1	35.66	8.23	84,139	6,921	98,887
1983	7.0	30.34	9.34	98,887	9,235	95,954
1984	8.8	31.26	10.21	95,954	9,800	93,719
1985	1.1	32.01	11.40	93,719	10,682	83,973
1986	13.3	35.73	12.64	83,973	10,618	83,118
1987	2.9	36.09	15.08	83,118	12,534	72,607
1988	-5.0	41.32	17.96	72,607	13,044	56,571
1989	9.2	53.03	21.24	56,571	12,015	48,675
1990	-13.7	61.63	33.01	48,675	16,070	28,140

Figure 1.



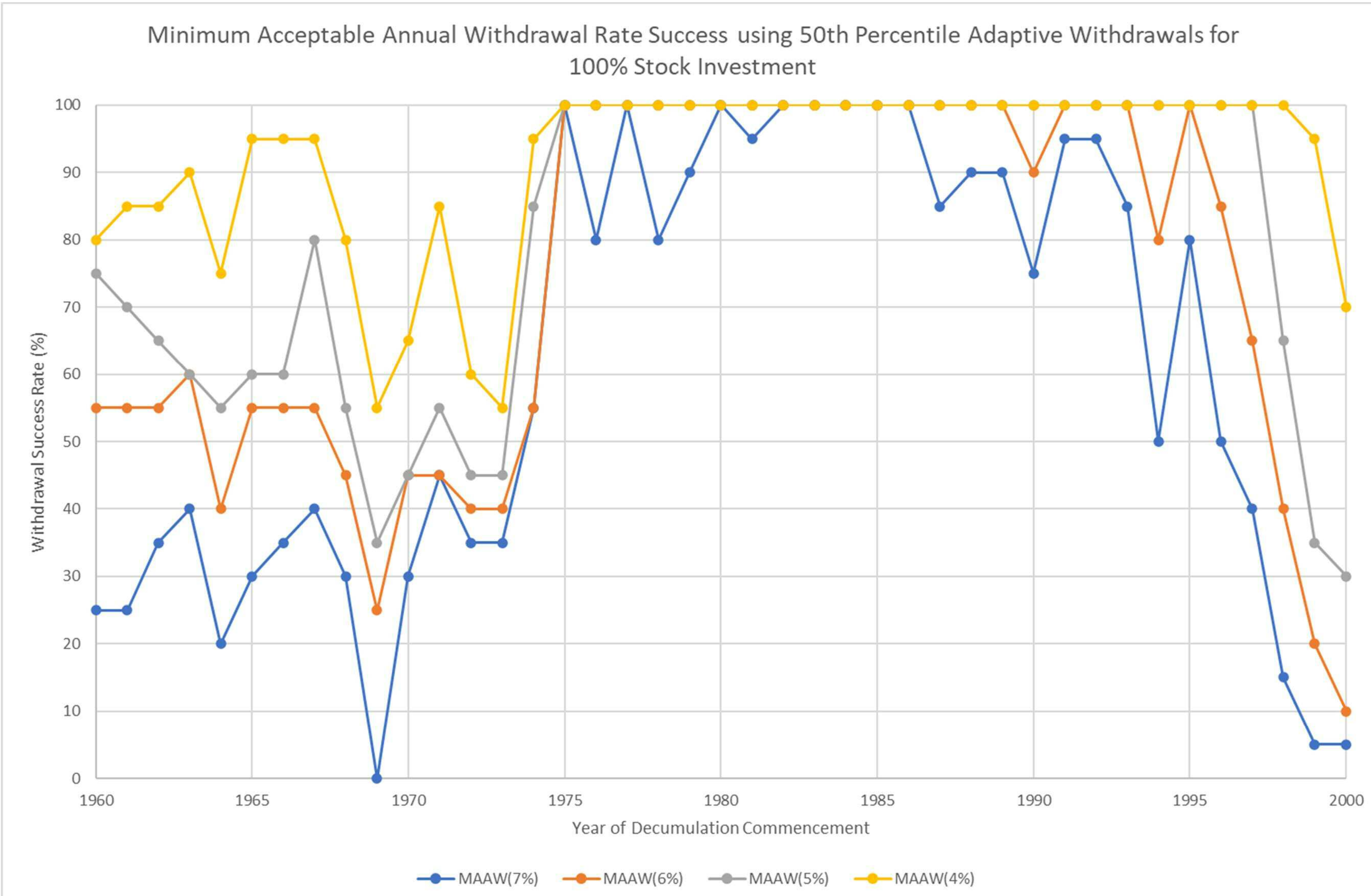
Realised 20-year Perfect Withdrawal Rates for 100% Stocks versus Percentiles based on Known Information at Start of Decumulation
18
16
14
12
10
8
6
4
2
0
Perfect Withdrawal Rate (%)
1900
1920
1940
1960
1980
2000
Year of Decumulation Commencement
Actual
50th %
25th %
10th %

Figure 2.



Remaining Balance and Years of Unfulfilled Withdrawals after 20 Years of Constant Decumulation
Invested in 100% Stocks at the Known Prior 25th PWR Percentile
Remaining Balance at End of Decumulation (% of Initial)
Full Years of Decumulation Remaining When Investment Pot Exhausted
Year of Decumulation Commencement
0
100
200
300
400
500
600
700
800
0
2
4
6
8
10
12
14
16
1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000

Figure 3.

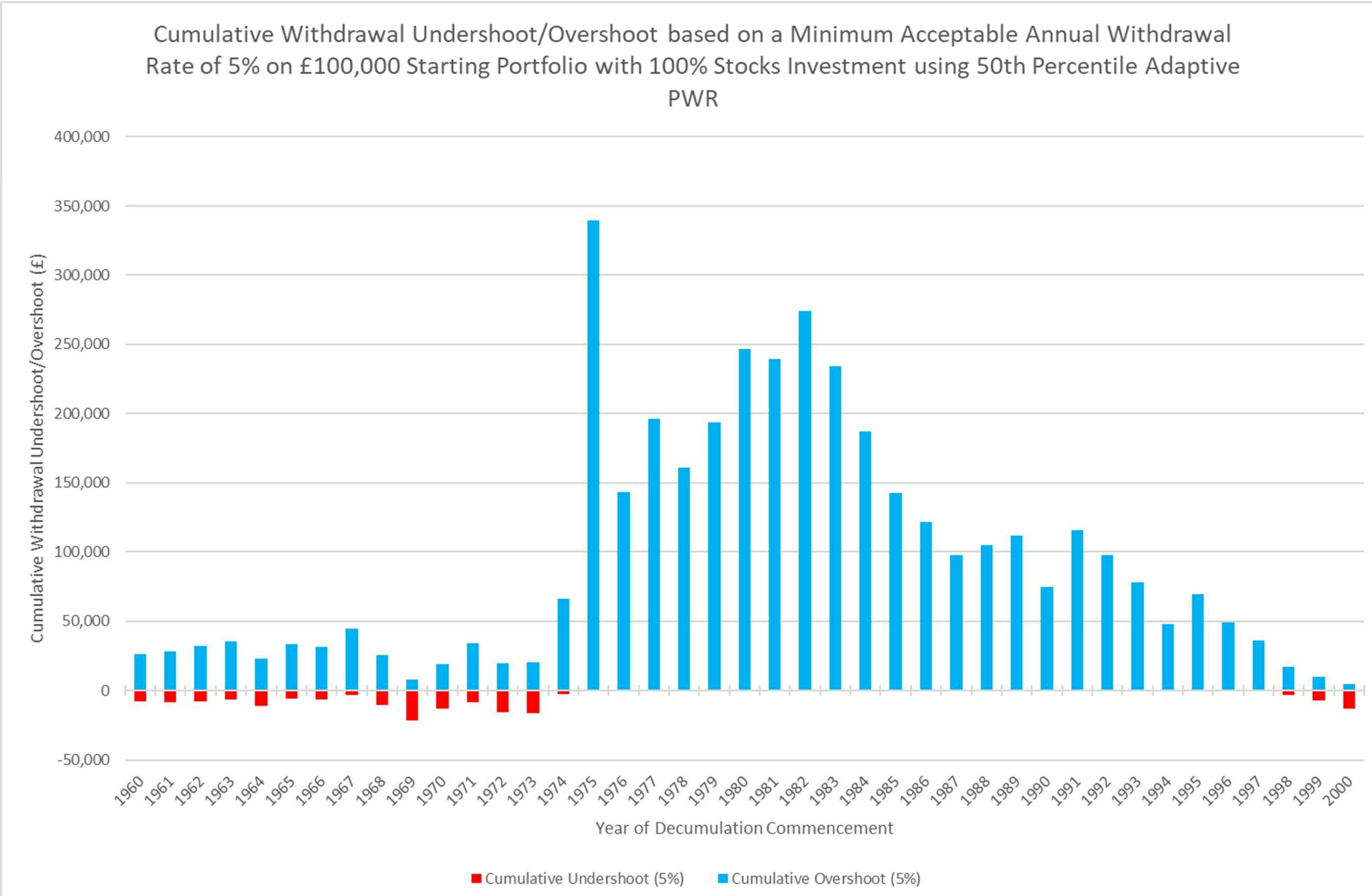


Minimum Acceptable Annual Withdrawal Rate Success using 50th Percentile Adaptive Withdrawals for 100% Stock Investment
Withdrawal Success Rate (%)
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
Year of Decumulation Commencement
MAAW(7%)
MAAW(6%)
MAAW(5%)
MAAW(4%)

Figure 4.

Minimum Withdrawal in 20-year Decumulation Period for 100% Stock Investment at the 50th Percentile Adaptive PWR
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Minimum Withdrawal (£)
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Year of Decumulation Commencement

Figure 5.



Cumulative Withdrawal Undershoot/Overshoot based on a Minimum Acceptable Annual Withdrawal Rate of 5% on £100,000 Starting Portfolio with 100% Stocks Investment using 50th Percentile Adaptive PWR
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
-50,000
Cumulative Withdrawal Undershoot/Overshoot (£)
1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Year of Decumulation Commencement
Cumulative Undershoot (5%)
Cumulative Overshoot (5%)

Figure 6.

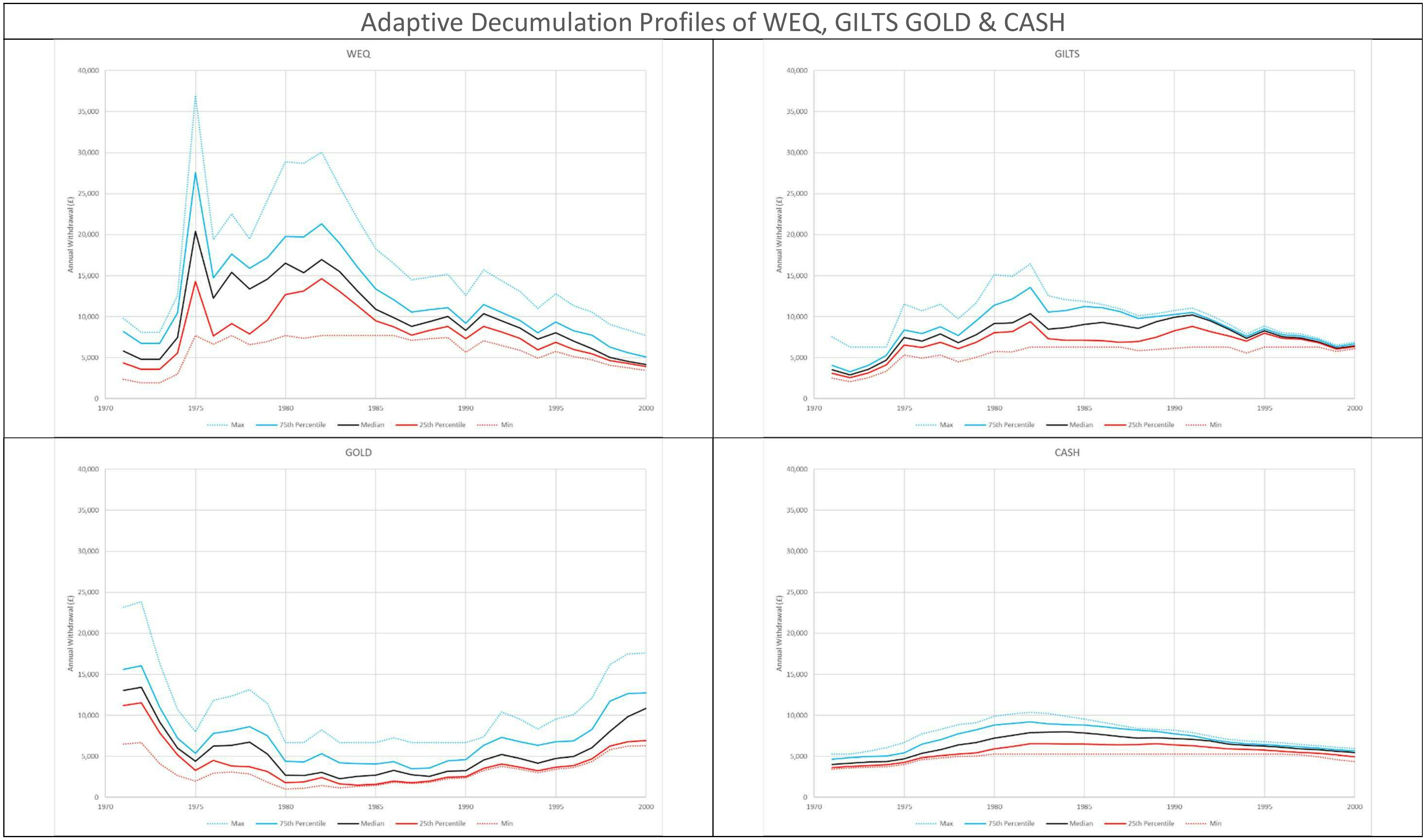

Adaptive Decumulation Profiles of WEQ, GILTS GOLD & CASH
WEQ
GILTS
GOLD
CASH
Annual Withdrawal (£)
Max
75th Percentile
Median
25th Percentile
Min

Figure 7.

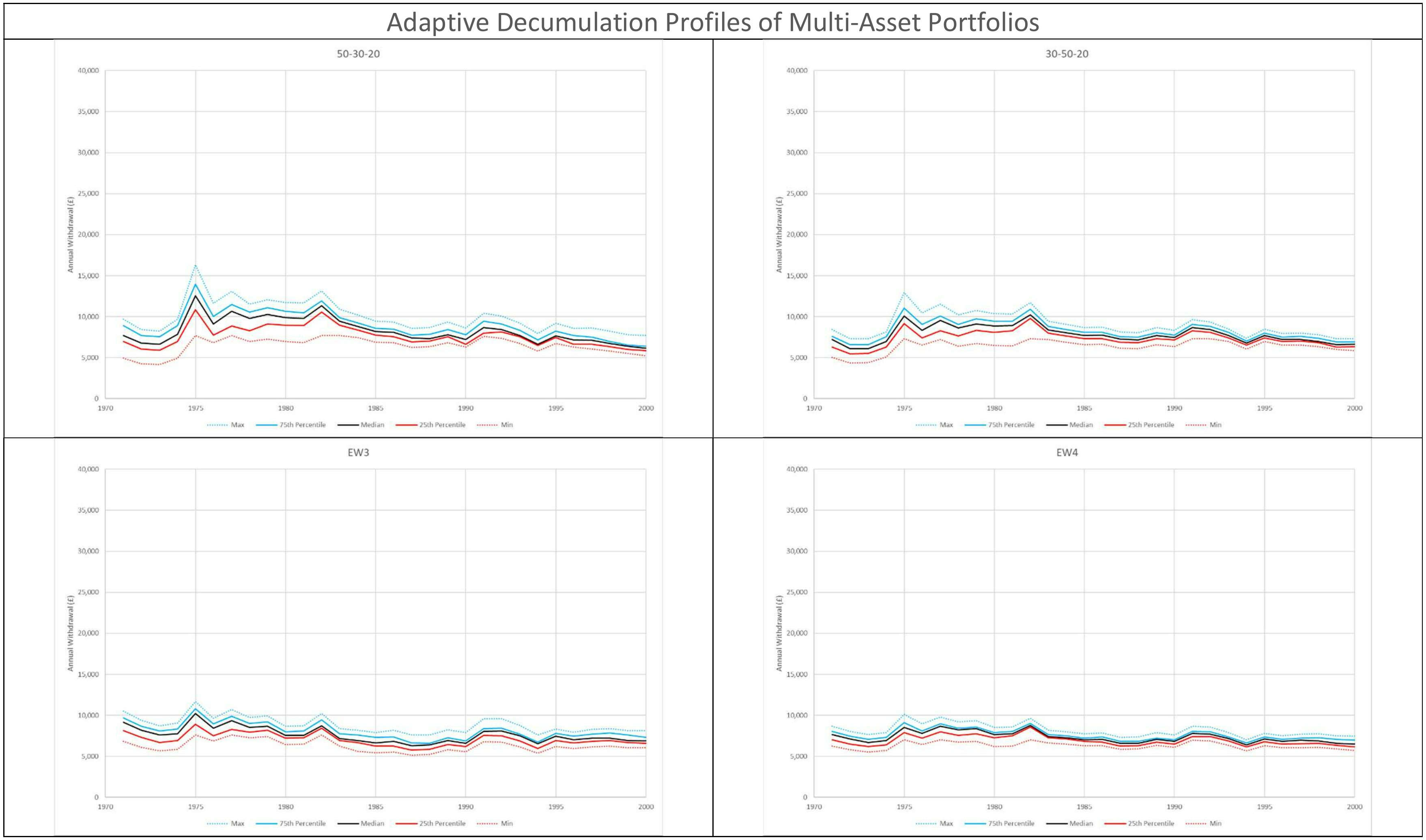
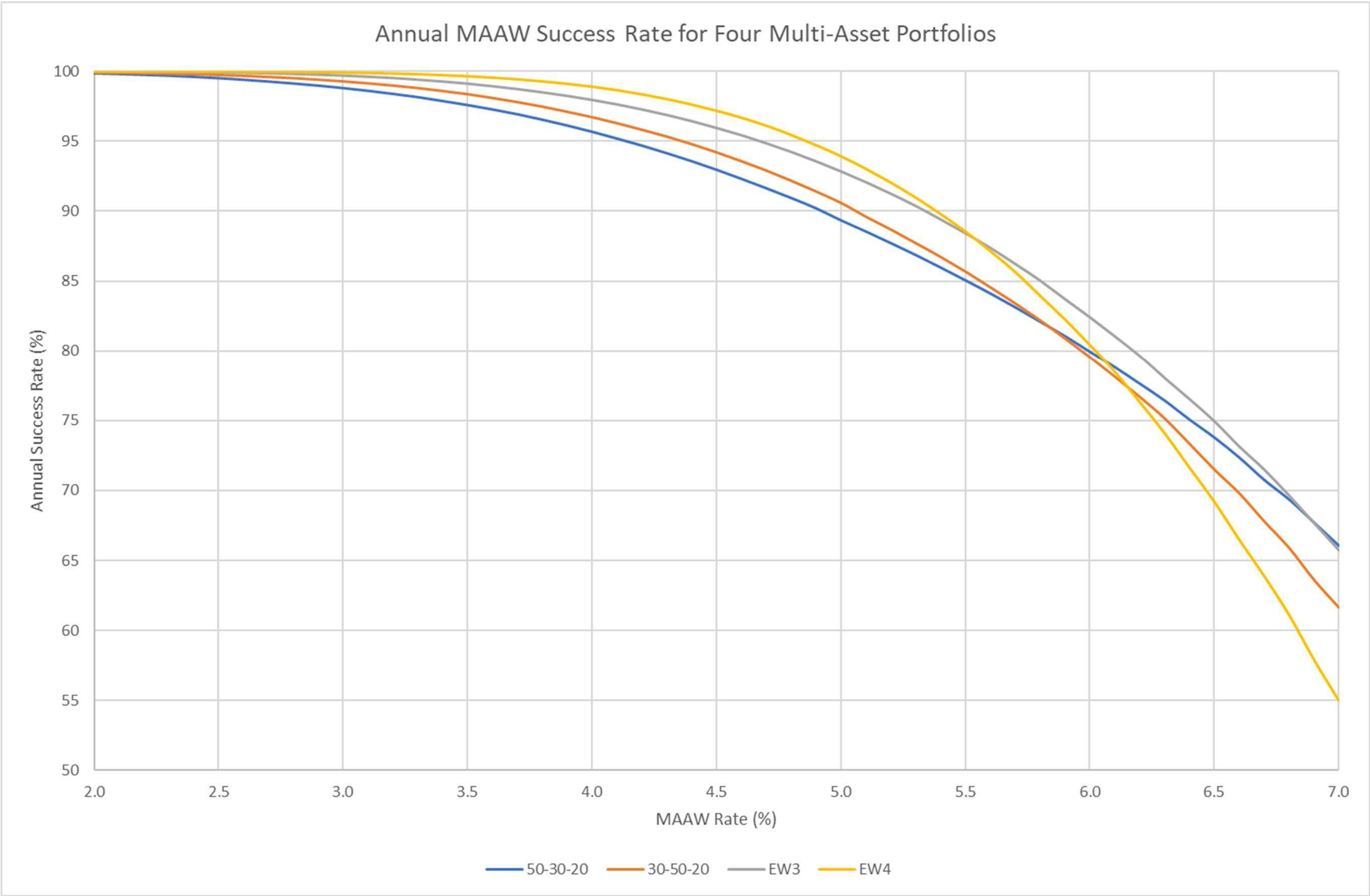
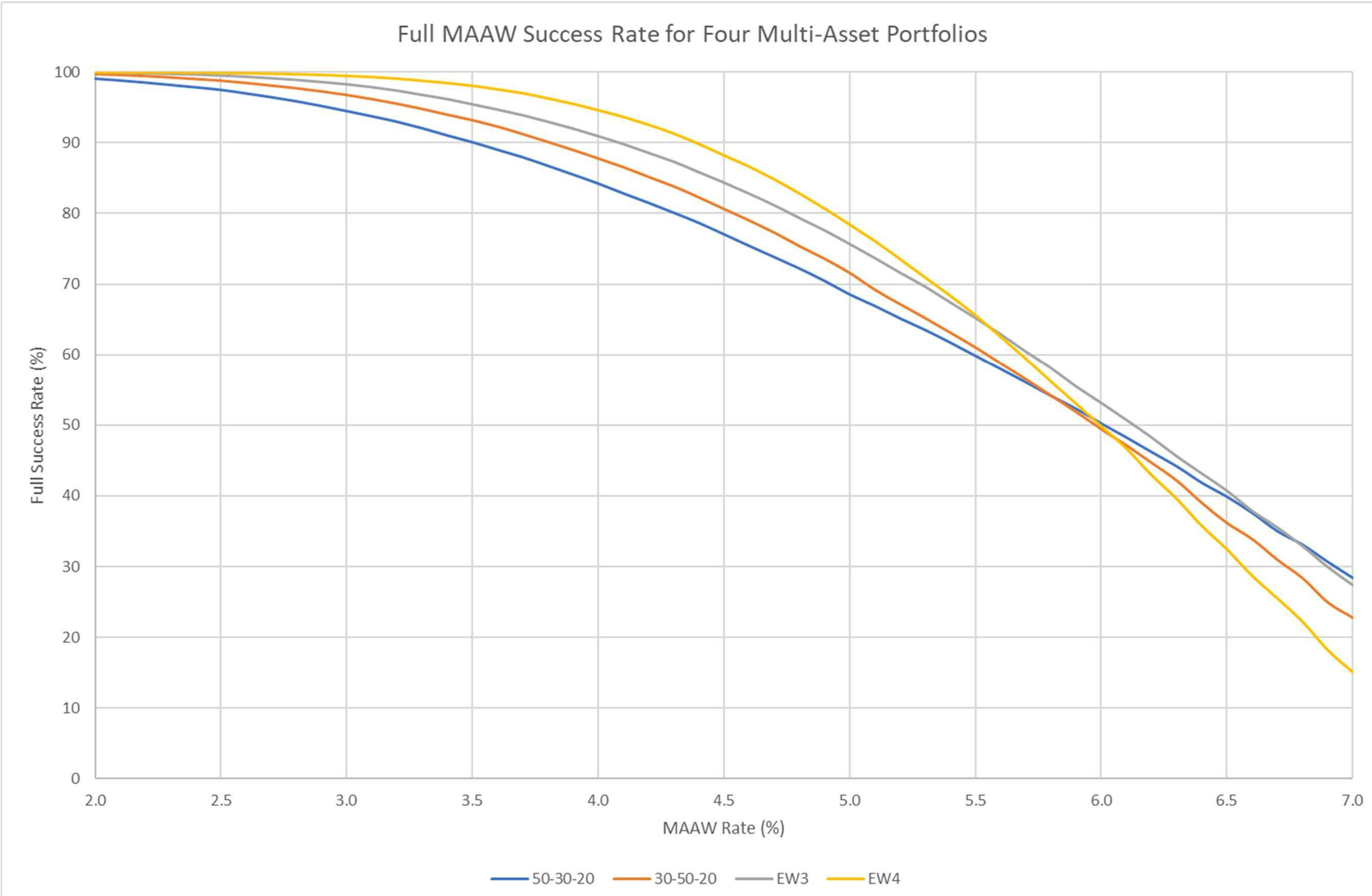

Adaptive Decumulation Profiles of Multi-Asset Portfolios
50-30-20
30-50-20
EW3
EW4
Annual Withdrawal (£)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1970
1975
1980
1985
1990
1995
2000
Max
75th Percentile
Median
25th Percentile
Min

Figure 8.



Annual MAAW Success Rate for Four Multi-Asset Portfolios
100
95
90
85
80
75
70
65
60
55
50
Annual Success Rate (%)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
MAAW Rate (%)
50-30-20
30-50-20
EW3
EW4

Figure 9.



Full MAAW Success Rate for Four Multi-Asset Portfolios
Full Success Rate (%)
100
90
80
70
60
50
40
30
20
10
0
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
MAAW Rate (%)
50-30-20
30-50-20
EW3
EW4

Figure 10.

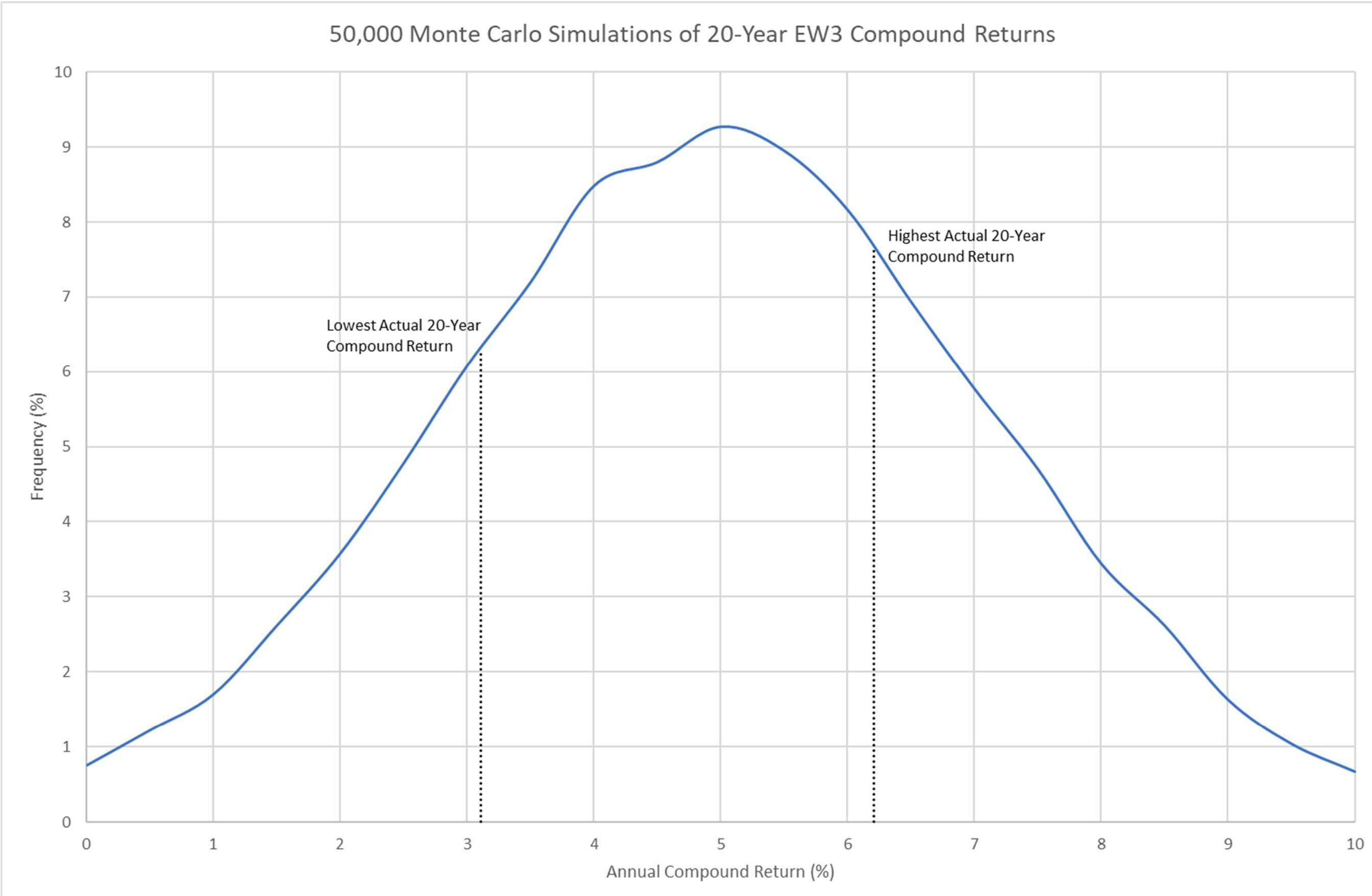

50,000 Monte Carlo Simulations of 20-Year EW3 Compound Returns
Lowest Actual 20-Year
Compound Return
Highest Actual 20-Year
Compound Return
Frequency (%)
Annual Compound Return (%)
0
1
2
3
4
5
6
7
8
9
10

Figure 11.

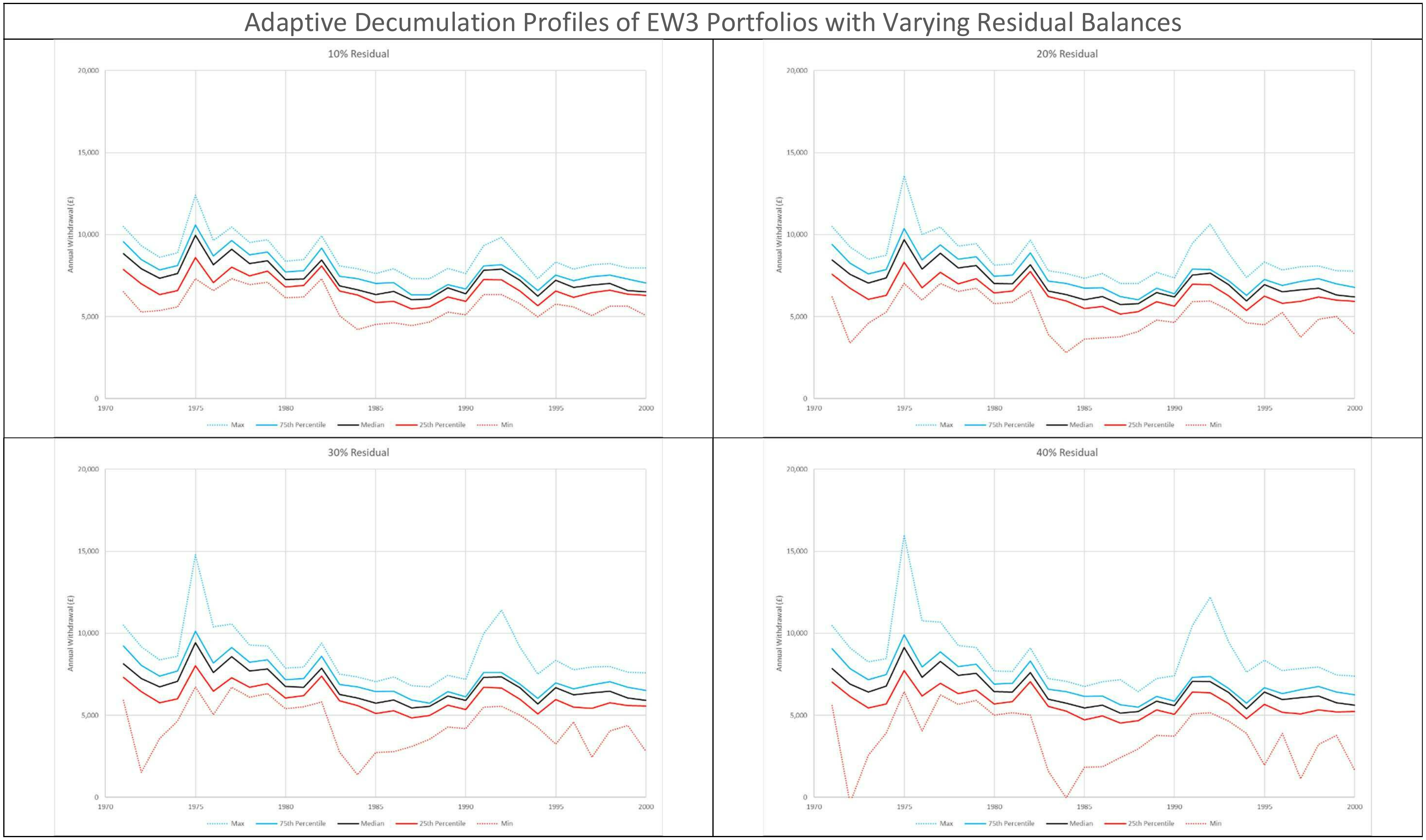

Adaptive Decumulation Profiles of EW3 Portfolios with Varying Residual Balances
10% Residual
20% Residual
30% Residual
40% Residual
Annual Withdrawal (£)
20,000
15,000
10,000
5,000
0
1970
1975
1980
1985
1990
1995
2000
Max
75th Percentile
Median
25th Percentile
Min

Figure 12.

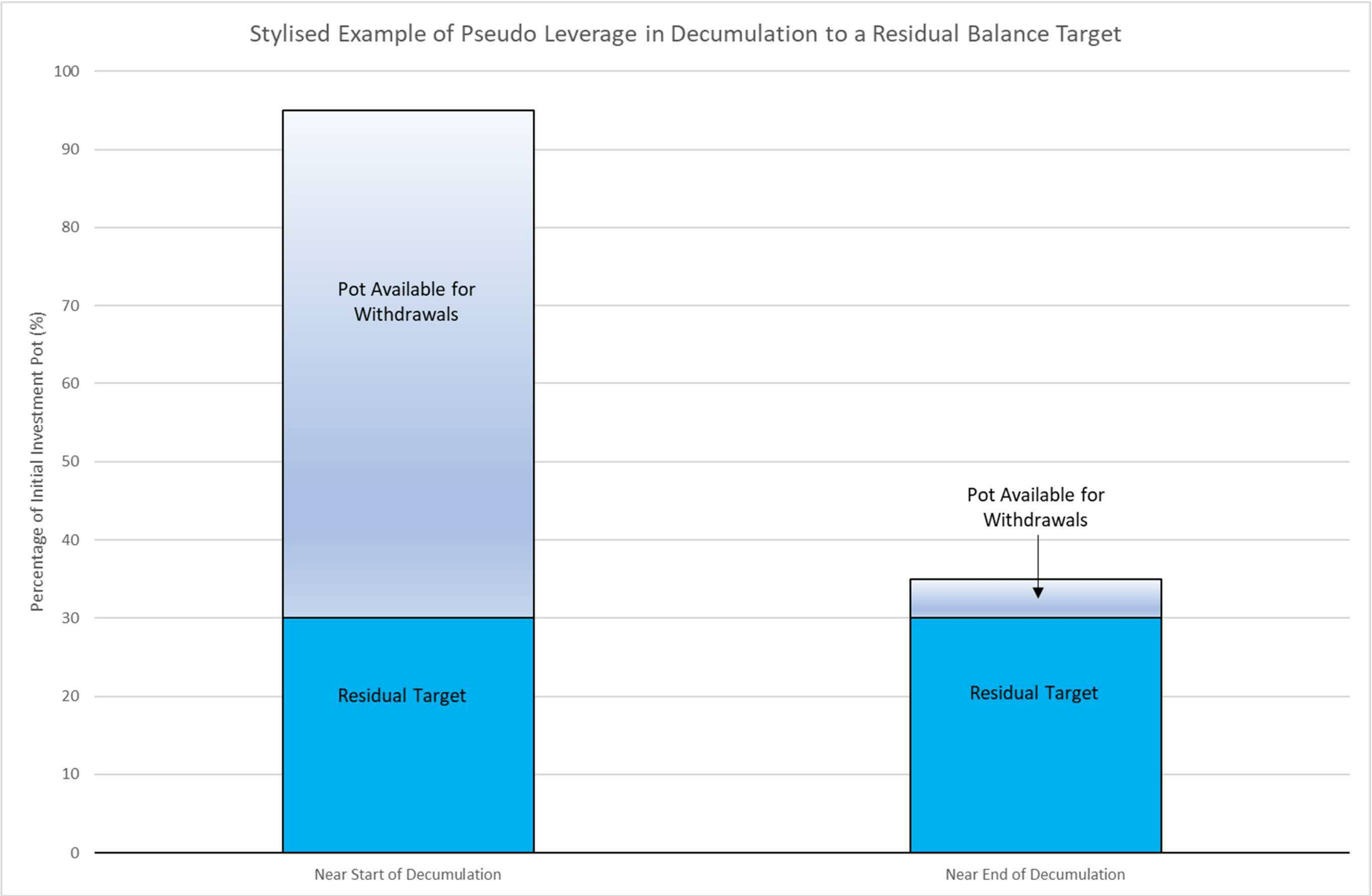
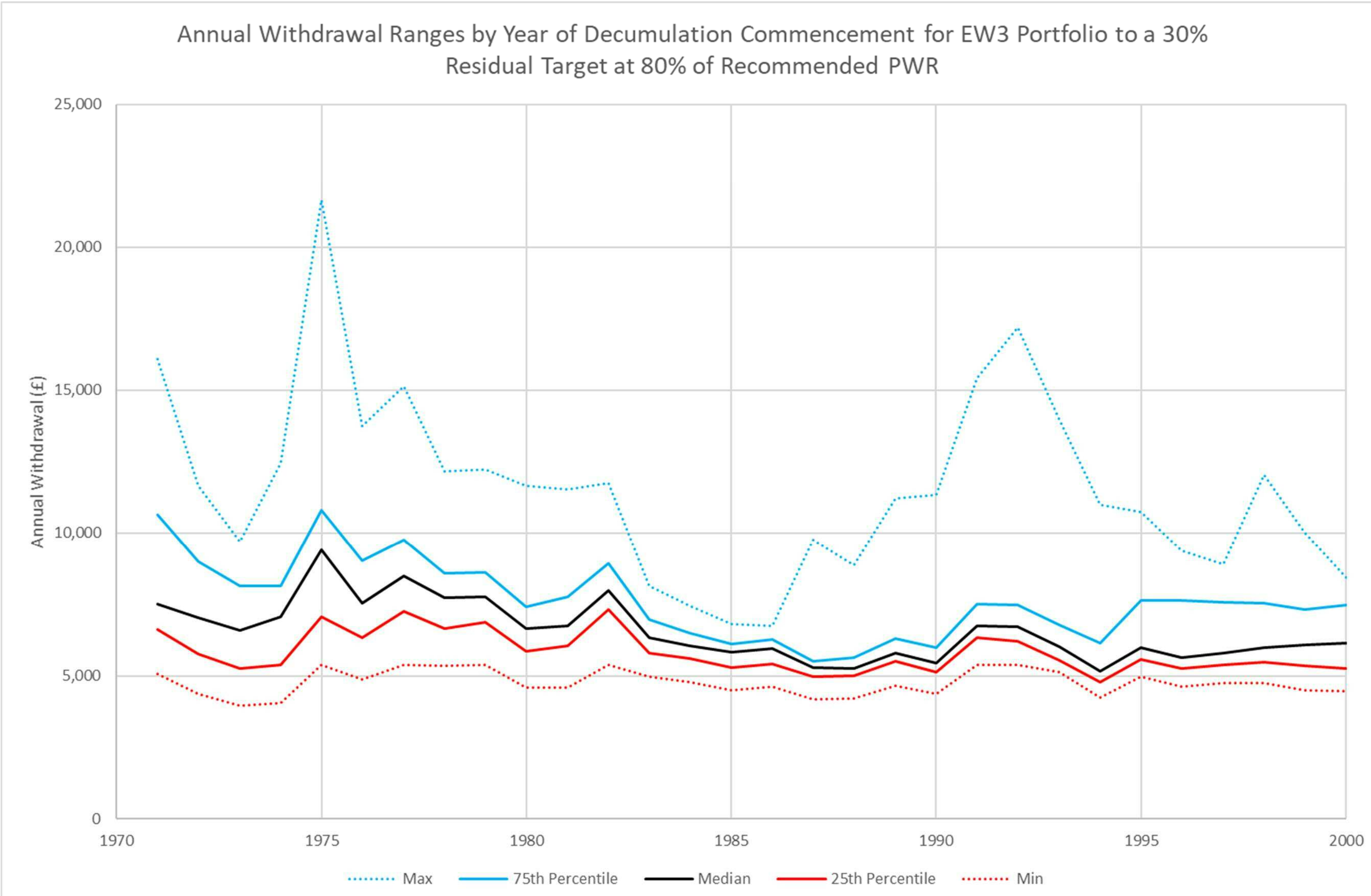
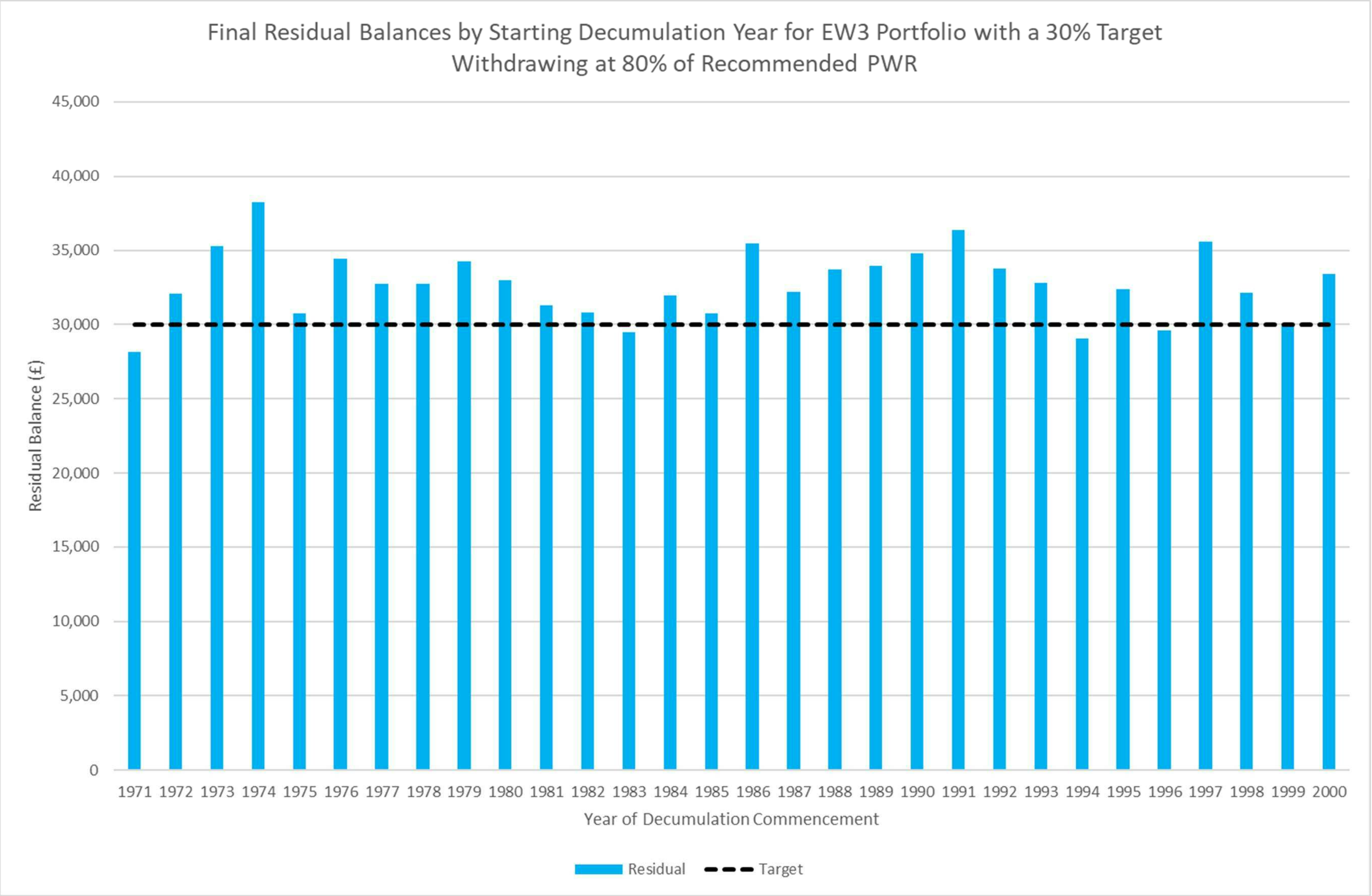

Stylised Example of Pseudo Leverage in Decumulation to a Residual Balance Target
Percentage of Initial Investment Pot (%)
100
90
80
70
60
50
40
30
20
10
0
Pot Available for Withdrawals
Residual Target
Pot Available for Withdrawals
Residual Target
Near Start of Decumulation
Near End of Decumulation

Figure 13.



Annual Withdrawal Ranges by Year of Decumulation Commencement for EW3 Portfolio to a 30% Residual Target at 80% of Recommended PWR
25,000
20,000
15,000
10,000
5,000
0
Annual Withdrawal (£)
1970
1975
1980
1985
1990
1995
2000
Max
75th Percentile
Median
25th Percentile
Min

Figure 14.



Final Residual Balances by Starting Decumulation Year for EW3 Portfolio with a 30% Target
Withdrawing at 80% of Recommended PWR
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Residual Balance (£)
1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Year of Decumulation Commencement
Residual
Target