

# The 6% Rule

by Gerald C. Wagner, Ph.D.

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## **Executive Summary**

- The 4% Rule appears to be alive and well. Advanced Monte Carlo simulations using expected asset class risks and returns that reflect the current economy show that the first year withdrawal can be increased by 2.5% each year and that portfolios with a 50% or more equity exposure can give a 90% chance of “spending success” over 30 years.
- The cash proceeds from various reverse mortgage plans can be taken in various ways. Scheduled monthly tax-free advances reduce the need for portfolio withdrawals and can give better “spending success” levels than line-of-credit draws.
- With a 30-year spending horizon and first-year withdrawal of 6.5%, reverse mortgage scheduled advances as a portfolio supplement give “spending success” levels of 91% – 95%. Even with a first year withdrawal of 7.0%, success levels are still 85% – 89%.
- After 15 years, portfolio balances are materially higher, more than offsetting the home equity being used by the reverse mortgage, i.e., overall net worth is higher.
- But is 30 years a long enough spending horizon? A couple in excellent health where the husband is 65 years old and the wife is 63 years old, have a 42% chance that someone will live past 30 years.
- Better planning would use a spending horizon where there is only a 10% chance that someone is still alive. For this couple that would be 37 years from now.
- At 37 years, absent a reverse mortgage supplement, the 4% Rule becomes the 3.5% Rule. A 3.5% first-year draw can be increased by 2.5% each year and portfolios with a 50% or more equity exposure can give a 86% – 92% chance of “spending success” over 37 years
- With a 37-year spending horizon and first-year withdrawal of 6.0%, reverse mortgage scheduled advances as a portfolio supplement give “spending success” levels of 88% – 92%. Even with a first year withdrawal of 6.5%, success levels are still 82% – 88%.
- The relative merits of using a reverse mortgage as a retirement spending supplement increase as future portfolio expectations are lowered.

Larry Bierwirth (1994) and William Bengen (1994) developed the 4% Rule which basically says that a person planning for a 30 year retirement, could withdraw 4% of their initial portfolio value in the first year, increase those withdrawals each year for cost-of-living changes, and expect to have a 90% chance of “spending success”. Spending success means that their portfolio would not be depleted over the 30 year spending horizon. Bengen called this the “SAFEMAX” withdrawal rate.

The order of portfolio returns is most important in spending success. If the portfolio experiences poor performance in the early part of the spending horizon, it is difficult for it ever to recover. The retiree will likely run out of money. Conversely if the first years have good performance,

sticking with the 4% Rule will most often result in a large portfolio surplus at the end of 30 years.

Because the portfolio is stochastic, and the 4% Rule is static, it has been much maligned. See especially Scott, Sharpe and Watson (2009). Several authors have suggested modifications such as no inflation increases following bad portfolio years, etc. In reality, investment advisors, retirement planners, and the retirees themselves will assess the situation over time -- retirement itself is a stochastic process.

A planner's goal is to be able to sit down with a couple (or person), review their portfolio and other income sources, and create a plan that is both logical and explainable. That is why the 4% Rule has become so popular. This paper shows that it works well with portfolios that are at least 50% invested in equities, and then shows how the use of a reverse mortgage can easily create new rules like the 6.5% Rule for a 30 year horizon and the 6% Rule for a 37 year horizon.

The primary reverse mortgage program available today is the FHA's HECM (Home Equity Conversion Mortgage). It comes in two versions: the Standard version includes a 2.0% FHA upfront mortgage insurance premium (MIP); the Saver version has only a de minimis upfront MIP, but has benefits that are 15 to 20% lower. Salter, Pfeiffer, and Evensky (2012) discussed various ways to use the HECM Saver in retirement. Sacks (2012) discussed various ways to use the HECM Standard line-of-credit as a supplement to portfolio withdrawals following a year of in which the portfolio returns were less than the desired withdrawal.

The HECM programs offer several ways of accessing the monies available. Upfront cash is needed to pay off any liens against the home and can be drawn for any other purpose. One cannot combine a reverse mortgage with a HELOC. A reverse mortgage must be in first position, and generally, does not allow any subordinate debt. With a reverse mortgage, a line-of-credit can be accessed as desired. In a HECM, its capacity (limit) grows each year at the loan's effective interest rate. The growing line-of-credit capacity feature makes the HECM a very fair product.

For example, with a note rate of 2.50% and ongoing MIP of 1.25% per annum, a loan's effective rate would be 3.75%. Imagine two borrower's each with a \$100,000 line-of-credit. One draws his entire line-of-credit upfront; the other lets his line-of-credit capacity grow untouched for five years. After five years the first borrower would owe \$120,588 – that's \$100,000 in principal and \$20,588 in accrued interest and MIP. The second borrower would owe nothing and have a line-of-credit capacity of \$120,588. If he then withdrew his whole line-of-credit, both borrowers would have the same outstanding loan balance.

Reverse mortgages are due and payable when the home is no longer the principal residence of the borrower(s). By definition they are nonrecourse loans. With a HECM, if the accrued loan balance exceeds the home value, the FHA insurance fund makes up the difference. Even if the loan is underwater, the heirs can buy the home for 95% of its then appraised value. It is a common misconception that the bank owns the home. This is not true. The borrowers own the home; they are responsible for maintaining the hazard insurance and paying the property taxes.

Besides upfront cash and a line-of-credit, the HECM programs have two different payment plans with monthly advances to the borrower. One is called a Term plan wherein a certain amount is advanced each month for a certain number of months. The advances then stop, but that does not mean the loan is due – it simply goes on accruing interest and MIP. The other payment plan is

called the Tenure plan (short for home tenure). This plan advances a certain amount each month so long as the home is the principal residence of the borrower.

For example, a 63-year old borrower with \$250,000 available for a payment plan could receive \$1,449 each month from a HECM tenure plan; that is \$17,387 per year, and since these are nontaxable loan advances, their tax equivalent value is considerably higher. If the marginal federal bracket was 28.0%, and they were in California (10.3%), the tax equivalent value of these tenure advances would be \$26,930. That works out to 10.8% per year on the \$250,000 of the loan proceeds committed to this payment plan.

If instead the same borrower wanted to use the \$250,000 for a term plan over 15 years, the monthly loan advance would be \$2,140 which is \$25,686 per year in advances that have a tax equivalent value of \$39,075. That works out to 15.9% per year on the \$250,000 committed to this term payment plan, but remember that advances will stop after 15 years. This paper shows that reverse mortgage scheduled monthly payment plans can provide greater retirement spending success and higher expected future portfolio values than various methods that involve drawing on a line-of-credit. Payment plans should be much easier to explain to clients, and to manage, than calculating and varying the line-of-credit draws each year.

**The Model:** All variables are stochastic and assumed to be log-normally distributed. Means and standard deviations in the model can be set as you wish. In this paper it is estimated that future annual home appreciation will be 3.0% with a 5.0% standard deviation; that the one-month LIBOR will average an annual rate of 2.07% (currently it's less than 0.25%) with a 0.53% standard deviation; and that annual future inflation (CPI-U) will average 2.50% with a 1.32% standard deviation.

For future portfolio returns, Michaud (2012), a seasoned forecaster of future asset class risks and returns, is used. In the model, the expected future return on an optimized portfolio with no equity exposure is 4.38% with a 9.90% standard deviation. The security market line ranges up to an expected future return of 8.30% on a portfolio that is 100% in equities having a standard deviation of 16.00%. These are nominal, not real returns. If future inflation averages 2.50% per year, a nominal return of 8.30% indicates a real return on equities of 5.80%. This is not much different than the real return on equity used in Finke (2013), but Michaud's 1.88% real return on fixed income is higher than that used in Finke. Pfau (2012) has an extensive literature review on safe withdrawal rates.

Given one portfolio, one desired first-year draw rate, and one spending horizon, 2,000 Monte Carlo simulations were run across thirteen options. The first used the portfolio only with no reverse mortgage. Six were various plans using the HECM Standard, and six were various plans using the HECM Saver. The various reverse mortgage plans are discussed below. For each run out of the 2,000 runs, four Monte Carlo arrays 50 years in length are created and used in calculating all 13 options. One array is the portfolio return, others are one-month LIBOR, inflation, and home appreciation. The 2,000 results are tabulated at the 'spending horizon'. They are also tabulated at an intermediate year as few retired people remain in their home for 30 years.

Across eight initial withdrawal rates ranging from 3.5% to 7.0%, across eight portfolios with equity exposure from 20% to 100%, and over two spending horizons (30 years and 37 years), the thirteen options required 1,664 Monte Carlo runs; each with 2,000 iterations -- and each iteration goes through 20,000 formulas.

First the 4% Rule was tested to find how it and other withdrawal rates succeed across various portfolio asset allocations. In Chart 1, the Red circle shows that portfolios that have equity exposure of 50% and higher reach close to or exceed the 90% success level predicted by the 4% Rule. Portfolios with less than 50% equity exposure have success levels commensurate with their equity exposure. Note that the 4% withdrawal rate success of portfolios with equity exposure of 50% and higher converge near the 90% success rate level. The extra volatility of the 100% equity portfolio makes its chances no better than the 80% equity portfolio.

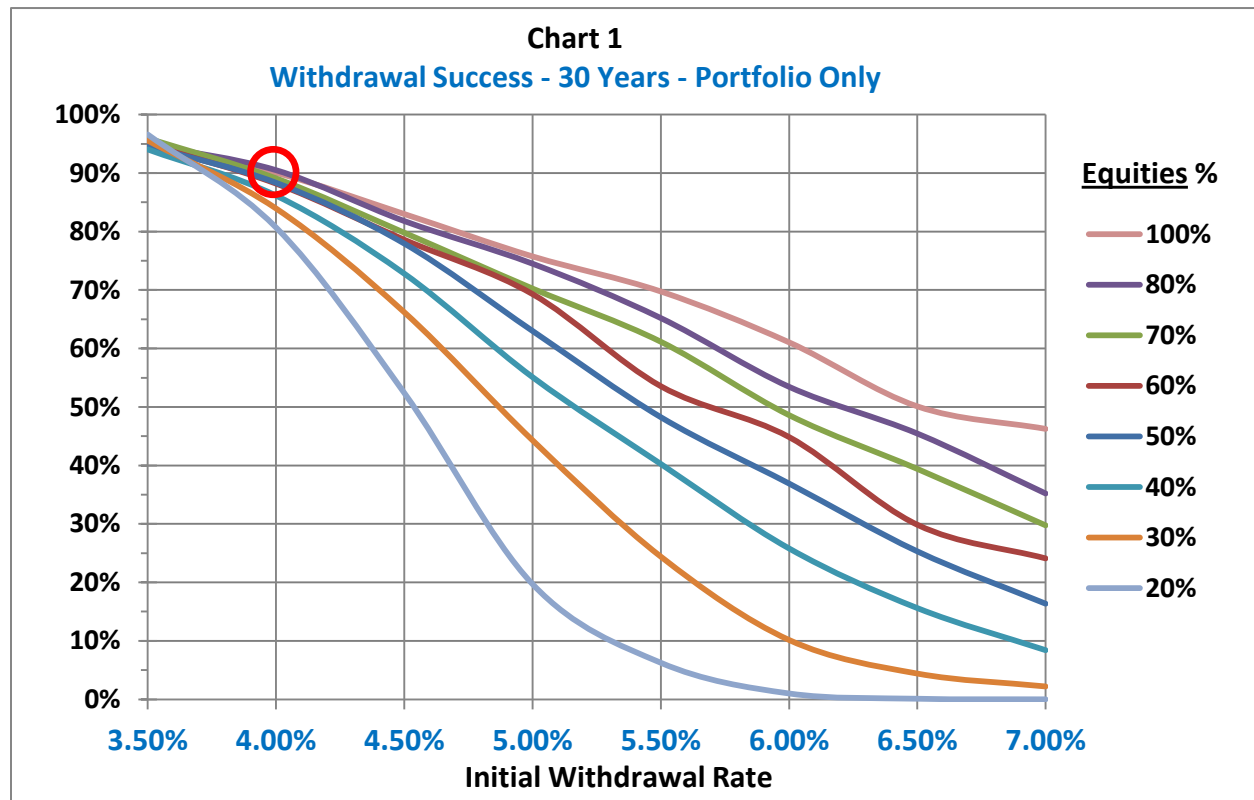


Chart 1 shows that a portfolio that is 60% in equities has only a 30% chance of withdrawal success if the initial withdrawal rate is 6.5% and grows, on average, by 2.5% each year. It will now be shown that a 6.5% withdrawal rate can exceed 90% success with the use of a reverse mortgage as a portfolio supplement.

**Supplement Portfolio Withdrawals with a Standard HECM Reverse Mortgage**

Six ways of accessing funds from a reverse mortgage across a spending horizon of 30 years are examined for a 63-year-old borrower living in a \$450,000 home and having a \$800,000 retirement portfolio. The first year’s desired withdrawal is 6.5% which is \$52,000. This is \$4,333 per month, and after paying federal and California taxes, leaves the homeowner with \$2,798 to spend. The six HECM reverse mortgage possibilities are:

Tenure Advances last as long as the home is the borrower’s primary residence. With the HECM, the monthly amount is calculated as a term loan to age 100. For the 63-year-old borrower that is 444 months and produces \$1,563 tax-free each month from the HECM. On a tax equivalent basis that is \$2,241, so to meet the desired withdrawal of \$4,333, only \$1,913 need be withdrawn from the portfolio each month during the first year. Since the HECM tenure advance is fixed, the

monthly portfolio withdrawal in the second year will be \$2,021. The \$108 increase over the first year accounts for the 2.5% expected annual inflation.

Term Loan Advances Over the Spending Horizon changes the monthly advance calculations to 360 months. The result is \$1,662 which has a tax equivalent value of \$2,574, so over the first year only \$1,759 need be withdrawn for the portfolio each month. Since the HECM term advance is fixed, the monthly portfolio withdrawal in the second year will be \$1,867 to account for the 2.5% inflation.

Term Loan First means setting up tax-free monthly HECM withdrawals of \$2,798 so the portfolio need not be touched. It works out that a standard HECM can do this for 133 months before its capacity is exhausted. Since the HECM term advance is fixed, the monthly portfolio withdrawal in the second year will be \$108 to account for the 2.5% inflation. With the term loan first option, the portfolio can grow with only minimal withdrawals for 11.1 years. After that time 100% of the spending money must come from the portfolio.

Line-of-Credit Draws First is discussed by Sacks (2012). In the example, \$2,798 is drawn from the HECM line-of-credit each month during the first year, and \$2,868 is drawn from the line-of-credit each month during the second year, etc. These withdrawals, growing each year with inflation, continue until the HECM is exhausted. The portfolio can remain untouched over this period. However, as will shown, this 'line-of-credit draws first' option is dominated by the 'term loan first' option because of the method HECM calculates monthly loan advances.

The note rate on a HECM varies each month based on the one-month LIBOR plus a set lender's margin. The HECM pricing model uses the 10-year LIBOR swap rate as a proxy for the next 120 months of the one-month LIBOR. Adding the lender's margin, this 10-year rate is called the Expected Rate. Advances under Term and Tenure payment plans are calculated using this Expected Rate plus the 1.25% MIP. But the line-of-credit grows only at the current 1-month LIBOR plus margin plus the 1.25% MIP. Think of a car loan, higher rates mean higher payments. That is why HECM scheduled payment plans dominate line-of-credit advances.

For example, assume that \$269,650 is available from a HECM reverse mortgage and that the spending horizon is 30 years. If the 10-year swap rate is 1.87% and margin is 2.50%, then the Expected Rate is 4.37%. A 30-year Term plan would give \$1,544.17 each month. If the 1-month LIBOR is 0.198% and margin is 2.50%, the Note Rate is 2.698%. So steady line-of-credit draws could amount to only \$1,275.08 each month. Thus, with today's rates, a Term plan can pay out 21% more than a line-of-credit plan. An inverted yield curve would reverse this effect.

Since the current 1-month LIBOR is historically low, simulations in these notes use 2.07%, the average for the last ten years. We note that the monthly average for the 1-month LIBOR for September, 2008, when Lehman Brothers fell, was 2.927%, and by January, 2009, the monthly average had dropped to 0.383%. Interesting times.

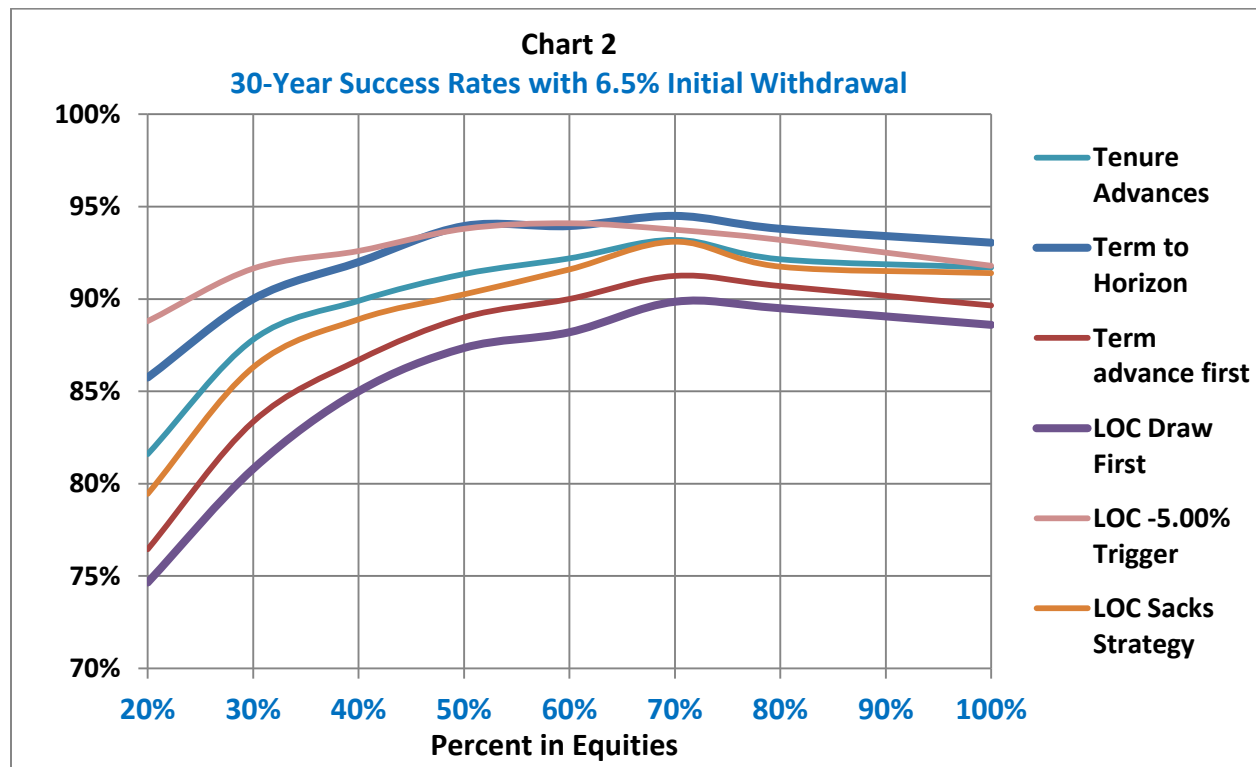
Line-of-Credit Draws with a Fixed Threshold such as -5% means that if the portfolio's return last year was less than -5%, make the entire after-tax monthly withdrawal from the HECM line-of-credit, for example the tax-free \$2,798, and don't touch the portfolio. However if the portfolio return was better than a loss of 5%, make the entire monthly withdrawal from the portfolio, for example a taxable \$4,333, and don't touch the HECM. 20 thresholds of annual portfolio returns ranging from +90% to -90% were tested. In the Monte Carlo runs an annual portfolio return of +90% is never reached so the results are the same as HECM 'line-of-credit draw first'. A -90%

threshold, that's minus 90% in one year, is always surpassed so the portfolio is always drawn first, and the HECM line-of-credit would be accessed only if and when the portfolio is depleted. As Sacks (2012) discusses, this 'reverse mortgage last' option has poor results. This is true.

Sacks' Coordinated Strategy consists of portfolio draws only from annual positive portfolio returns. Any shortfall in the desired annual withdrawal is made up by drawing on the reverse mortgage line-of-credit. When the reverse mortgage line-of-credit is exhausted, all withdrawals are made from the portfolio regardless of its annual returns. See Sacks (2012) footnote 6.

Chart 2 plots success rates for these six reverse mortgage options across various portfolios. Portfolios that are 60% or more invested in equities are very successful in meeting desired withdrawals. The sweet spot for spending success appears to be portfolios that are 70% invested in equities. Their chances of spending success range from 89.9% for the 'line-of-credit draw first' option up to 94.5% for the 'term loan advances to spending horizon' option. With that option, loan advances stop at the end of 30 years hence it bests the 'tenure advances' option. That's because tenure advances are calculated to when the borrower will reach age 100. In this case that is 37 years. However tenure advances continue indefinitely, even if the homeowner lives to be 110. Using a 30-year spending horizon, no credit is given for those extra advances.

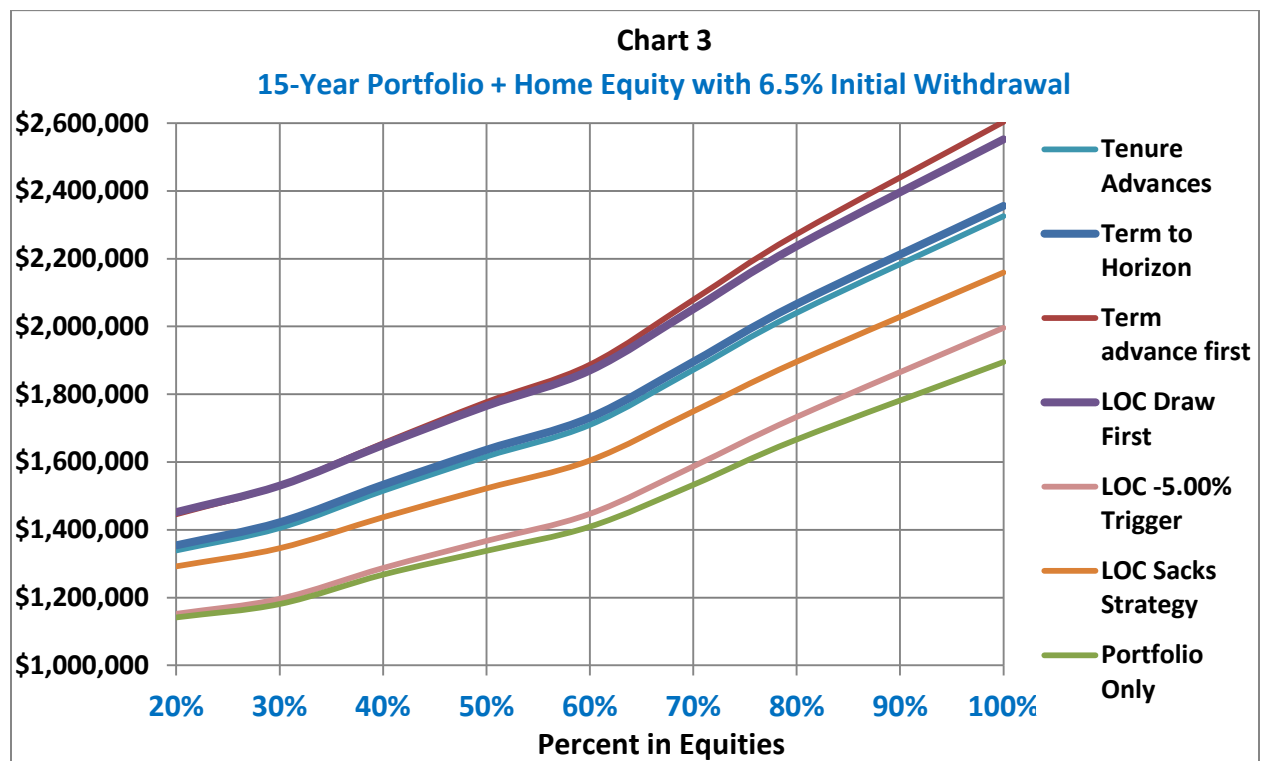
If success over a spending horizon is all that matters, you can see that a portfolio need never be invested in more than 70% equities. Bengen (1994) states that "Stock allocations below 50 percent and above 75 percent are counterproductive." It appears that he may be correct.



30-year success rates are important to give your client a sense that their retirement planning is sound. Average portfolio balances, home values, and loan balances have been calculated at thirty years; but thirty years is a long way off. As abundantly pointed out in the literature, if spending

withdrawals are successful over 30 years, there may be millions of dollars left on the table. More meaningful results would be those at some intermediate period, say fifteen years.

Chart 3 shows the retirees expected net worth at the end of 15 years. This is the total of their expected portfolio balance and their remaining home equity. With the ‘Portfolio Only’ (no reverse mortgage) option, the home equity is the entire future home value. Obviously the highest portfolio balances result in the two options where the reverse mortgage is drawn first and the portfolio is allowed to grow with little or no withdrawals for much of the 15 years. The lowest two portfolio balances among the reverse mortgage options are those where the line of credit is used only intermittently. The less a reverse mortgage is utilized, the more is drawn for the portfolio, and hence, the lower the portfolio balance. Greater utilization of the reverse mortgage gives higher portfolio balances, but necessarily uses up home equity. You can see that the six reverse mortgage options give higher overall results across all portfolio equity mixes than just relying on the portfolio as the source of retirement spending.



**Two reverse mortgage strategies dominate**, and which to choose depends on your client’s comfort level in using home equity to supplement portfolio withdrawals. One strategy is reverse mortgage first, and the ‘term plan first’ plan dominates the ‘line-of-credit first’ plan in both withdrawal success and expected net worth. If the portfolio is invested 60% in equities, the ‘term plan first’ plan would give a 90% chance of withdrawing 6.5% annually over 30 years (rising with inflation) versus a 29.9% chance that the portfolio, going it alone, could give these desired withdrawals, and, at 15 years, your client’s net worth could be \$478,000 higher.

The second strategy is reverse mortgage ‘term advances over the spending horizon’. Expected net worth is less than the first strategy, but at 15 years the loan balance is smaller, and the 30 years spending success rate is several points higher. If the portfolio is invested 60% in equities, the ‘term advances over the spending horizon’ plan would give a 94% chance of withdrawing

6.5% annually over 30 years (rising with inflation), and, at 15 years, your client’s net worth could be \$322,000 higher.

**Mortality:** Generally a client must plan ahead longer than one thinks. The notes above are calculated over a 30-year spending horizon. It is important that clients realize that “life expectancy” is a median – there is a 50% chance that they will live past their life expectancy. Say that Marilyn is a 63-year old female in excellent health; her life expectancy is 24.8 years. This means there is a 50% chance that she will live to be 88 or older. If her health was only average, Marilyn would have a 50% chance of living to age 84 or older [1].

Her husband George is a 65-year old male in excellent health with a life expectancy of 20.4 years. This means there is a 50% chance that he will live to be 85 or older. If his health was only average, George would have a 50% chance of living to age 81 or older.

Given that they are both in excellent health, there is a 68% chance that Marilyn will outlive George. At his life expectancy, she will be 83 and could expect to survive by 8.5 years (again a median figure). And there is a 32% chance that George will outlive Marilyn. At her life expectancy, he would be 90 and could expect to survive her by 4.9 years.

There is a 50% chance that at least one of them will be alive in 28.6 years. This is known as a last-to-die joint life expectancy. With a 30-year spending horizon, annuitant mortality tables tell us these probabilities:

	Marilyn	George	Both	Someone
<b>Age Then</b>	93	95		
<b>Is Alive</b>	30.8%	16.5%	5.1%	<b>42.2%</b>
<b>Widowed</b>	25.7%	11.4%		

So if planning over only 30 years, there is a 42% chance that at least one of them will outlive their money. To be prudent, it would be safer to choose a planning horizon where there is only a 10% chance that someone is still alive. With Marilyn and George, the nearest full year that gives close to a 10% probability is **year 37** where there is a 11.6% chance that someone is still alive.

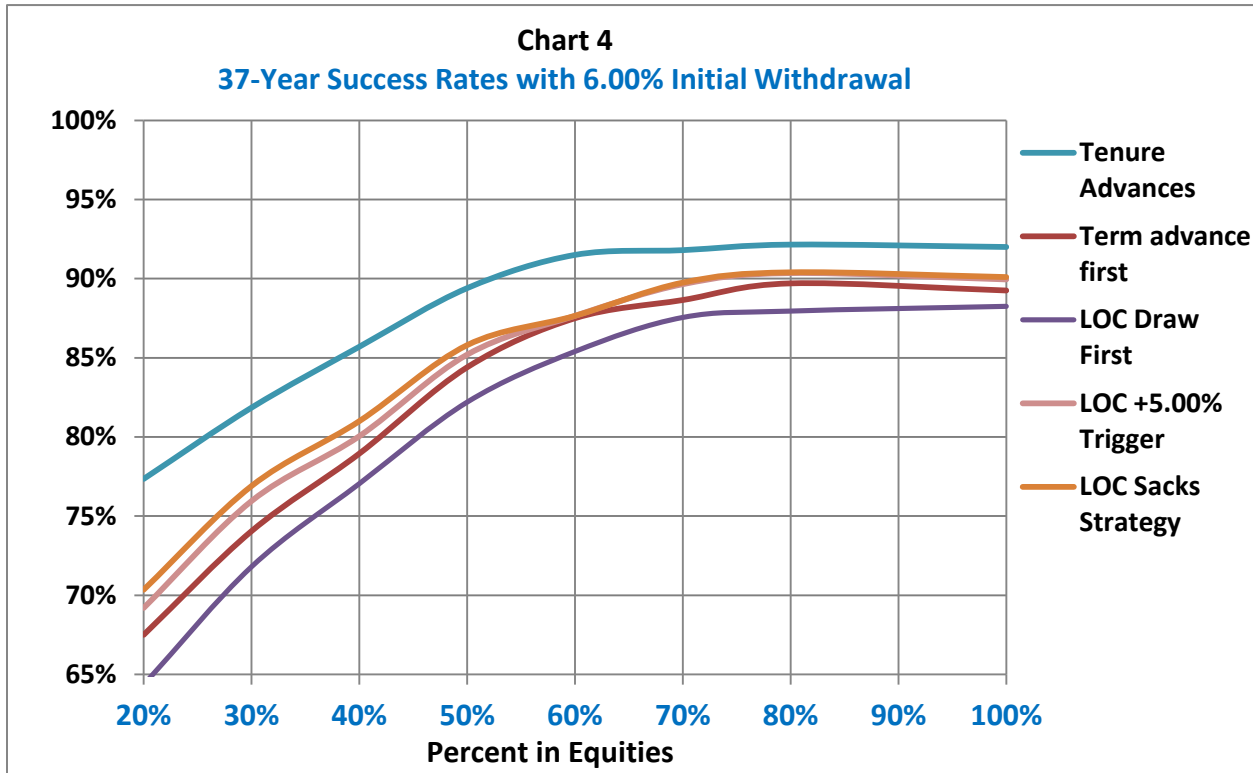
	Marilyn	George	Both	Someone
<b>Age Then</b>	100	102		
<b>Is Alive</b>	8.5%	3.5%	0.3%	<b>11.6%</b>
<b>Widowed</b>	8.2%	3.2%		

**Planning over a 37-year period** eliminates the advantage of the ‘term to horizon’ reverse mortgage advance option. This is because the HECM ‘tenure advance’ is calculated to when the younger borrower reaches age 100, yet the monthly advances continue indefinitely. In this example, a 37-year ‘term to horizon’ plan would result in the same monthly advance dollars, but the term advances would stop when the younger borrower reached age 100.

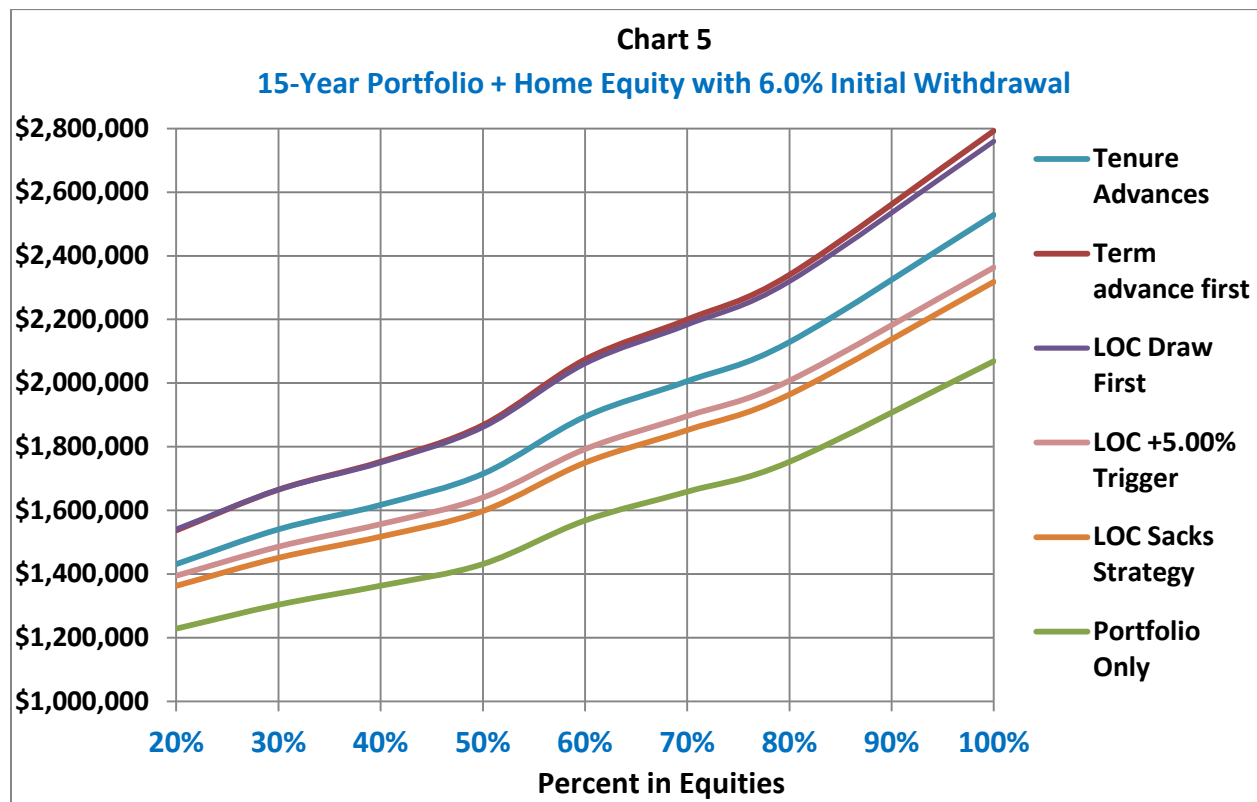
Over 37 years, the portfolio alone can only support a 3.5% first-year withdrawal if the expected failure rate is to not exceed 10%. This is possible with portfolios that are 60% or more invested in equities. Chart 4 shows that the first year withdrawal can safely be increased to 6.0% with a



reverse mortgage supplement. This is 71% higher annual spending in retirement when compared to the 3.5% that the portfolio going it alone could provide.



The expected portfolio balance will obviously be higher in 15 years if a reverse mortgage is used to supplement portfolio withdrawals, but home equity will be lower as funds are withdrawn from the reverse mortgage. As seen in Chart 5 the total of the portfolio balance and the home equity is materially higher at 15 years when a reverse mortgage is used.



**Again two reverse mortgage strategies dominate.** One strategy is reverse mortgage first, and the ‘term plan first’ plan dominates the ‘line-of-credit first’ plan in both withdrawal success and expected net worth. If the portfolio is invested 60% in equities, the ‘term plan first’ plan would give a 87.5% chance of withdrawing 6.0% annually over 37 years (rising with inflation) versus a 29.0% chance that the portfolio, going it alone, could give these desired withdrawals, and, as shown in Table 1, at 15 years your client’s net worth could be \$479,000 higher.

The second strategy is a reverse mortgage ‘home tenure’ plan. Expected net worth is less than the first strategy, but at 15 years the loan balance is smaller, and the 37 year spending success rate is several points higher. If the portfolio is invested 60% in equities, the ‘home tenure’ plan would give a 91.5% chance of withdrawing 6.0% annually over 37 years (rising with inflation), and, as shown in Table 1, at 15 years your client’s net worth could be \$307,000 higher.

**Notes on the HECM Saver:** This program is best for those with shorter planning horizons. The 1.99% of home value saved by a lower initial Mortgage Insurance Premium (MIP) is partially offset by higher loan fees and margins [2]. With a 63-year old borrower in a \$450,000 home, the initial Saver benefit would be \$38,595 less than that of a ‘HECM Standard’ and monthly tenure advances would be 11.8% smaller. Ignoring the greater portfolio supplement benefits of the Standard, the Annual Percentage Rate (APR) crossing point of a tenure loan is about 15 years off. That is the point where the Standard’s higher tenure income stream fully amortizes the Standard’s higher initial costs.

With a 6% initial draw rate and a portfolio invested 60% in equities, The Saver gives about a five percent less chance of spending success at 37 years. Table 1 compares the results after 15 years for the two dominant payment plan options. And we note that the client’s net worth (Home Equity plus Portfolio) is 2-3% less with a Saver.

<b>Table 1</b>	<b>37-Year Spending Success</b>	<b>Results After 15 Years</b>			
		<b>Home Equity</b>	<b>Portfolio Balance</b>	<b>Extra Pays Off Loan</b>	<b>Home plus Portfolio</b>
<b>6% Initial Draw</b>					
With No Reverse	30.5%	723,256	831,326	--	1,554,582
<b>HECM Standard</b>					
Tenure Advances	<b>89.9%</b>	261,953	1,599,800	79.9%	1,861,752
Term Advance First	85.0%	61,318	1,972,176	80.4%	<b>2,033,495</b>
<b>HECM Saver</b>					
Tenure Advances	<b>84.7%</b>	318,355	1,508,868	80.5%	1,827,224
Term Advance First	80.4%	148,976	1,827,198	79.0%	<b>1,976,175</b>
<b>Saver vs. Standard</b>					
Tenure Advances	-5.2%	56,403	-90,932	0.6%	-34,529
Term Advance First	-4.6%	87,658	-144,978	-1.4%	-57,320

**In a Low-Yield World:** Using recent market conditions as predictors, rather than historical security returns, Finke (2013) suggests that 2.5% may be the new SAFEMAX. Using the Finke future market conditions as inputs, we found a 92.5% chance of spending success over 30 years with an initial withdrawal of 2.5%. With a 4.0% initial withdrawal, the portfolio alone has only a 66.5% chance of spending success; adding reverse mortgage options raised success rates to 97-98%. And with a 5.0% initial withdrawal, the Finke portfolio alone has only a 46.0% chance of success; adding reverse mortgage options raised spending success rates to 89-92%.

5.0% versus a 2.5% initial withdrawal rate indicates that one can double expected spending over a 30-year retirement horizon by adding a reverse mortgage supplement. And, at 15 years, the extra net worth with the reverse mortgage options ranged from \$268,000 to \$395,000. So if one believes that a low-yield world is the future, reverse mortgages can play a role even more decisive than that expressed in the bulk of these notes.

**Summation:** The benefits of using a reverse mortgage will vary depending on the relative initial values of the portfolio and the home. The examples shown in these notes are based on a \$450,000 home and a \$800,000 portfolio. The monies available from a reverse mortgage are based on home values, so the larger the home value with respect to the portfolio, the greater the relative benefit from a reverse mortgage.

The examples show that the 37-year success rate of a 6.0% initial withdrawal is 88-92%. If the home was valued at \$250,000 rather than \$450,000, the initial withdrawal rate would have to be reduced to 5.0% to have a 86-89% success rate. But this is still clearly better than the 37-year, 3.5% withdrawal rate which the portfolio, without a reverse mortgage, could supply. And if the home is valued at \$250,000 rather than \$450,000, the 15-year increase in net worth compared to a “no reverse” strategy is still \$425,000-\$640,000.

**Appendix 1**

Portfolios were constructed using future asset class risks and returns as estimated by Michaud 2012. For simplicity, only three asset classes were used in this paper as shown in Table 2. Expected returns are nominal returns, not real returns adjusted for inflation. The Expected Return and Standard Deviation of any portfolio can be entered into the model.

**Table 2**

Asset Classes	Expected Return	Standard Deviation	Correlations		
			ST Fixed	LT Bond	LC Equity
Short Term Fixed Income	3.5%	1.2%	1.00	-0.01	0.07
Long Term Bond	4.4%	10.1%	-0.01	1.00	0.24
Large Cap Equity	8.3%	16.0%	0.07	0.24	1.00

Simulations were run using the eight portfolios shown in Table 3. Equity exposure ranged from 20% to 100%.

**Table 3**

Eight Portfolios	1	2	3	4	5	6	7	8
Short Term Fixed Income	56.4%	34.7%	12.9%	2%	2%	2%	2%	0%
Long Term Bond	23.6%	35.3%	47.1%	48%	38%	28%	18%	0%
Large Cap Equity	<b>20%</b>	<b>30%</b>	<b>40%</b>	<b>50%</b>	<b>60%</b>	<b>70%</b>	<b>80%</b>	<b>100%</b>
	100%	100%	100%	100%	100%	100%	100%	100%
Expected Return	4.67%	5.26%	5.84%	6.33%	6.72%	7.11%	7.50%	8.30%
Standard Deviation	4.50%	6.66%	8.85%	10.30%	11.16%	12.19%	13.36%	16.00%
Sharpe Ratio	0.26	0.264	0.265	0.275	0.289	0.296	0.30	0.30
Price of Variance Risk	23.0	11.8	7.5	6.0	5.4	4.8	4.2	3.2

The Monte Carlo simulations showed that “spending success” peaked with about a 70% equity exposure. Table 3 shows that the Sharpe Ratio is essentially flat from 70% equities upward. That indicates no extra reward for going above 70%; Sharpe uses the standard deviation as his denominator. If variance is the denominator, the Price of Variance Risk is found; and it keeps declining as equity is added. This means that there is less and less incremental return for the extra portfolio volatility being taking on. Since the goal is not the highest return, but instead to make steady, increasing withdrawals without running out of money, extra volatility, even with extra returns, can lower the chances of withdrawal success. This merits future study.

**End Notes:**

**1:** For individuals in excellent health, 1996 US Annuity 2000 tables as published by the Society of Actuaries were used. For individuals in average health, general population U.S. Decennial Life Tables as published by the National Center for Health Statistics were used.

**2:** The simulations follow industry practice in late 2012. The HECM Standard has no origination fee; the HECM Saver has a \$3,000 fee. The lender’s interest rate margin on the Standard is 2.25%; on the Saver, it is 2.50%. Both programs have \$2,600 in initial third-party costs.

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**5,407 words including the bibliography, 5 charts, 3 tables**