SENSITIVITY OF SAFE WITHDRAWAL RATES TO LONGEVITY, MARKET AND FAILURE RISK PREFERENCES WITH IMPLICATIONS FOR ASSET ALLOCATION

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Abstract

Retirees face longevity risk, or the risk of living longer (or less long) than expected; market risk, or the risk of poor investment returns over the retirement horizon, and finally; failure risk, or the risk of running out of money before death. The authors examine the sensitivity of these three risks to asset allocation and Safe Withdrawal Rates, and offer a model to optimize these factors in order to minimize the three primary risks in the context of personal preferences. Finally, a forecast model is proposed to link Safe Withdrawal Rates to contemporaneous stock market valuations and interest rates, with strong statistical significance.

According to the Pew Research Center, in 2011 the oldest members of the baby boomer generation turned 65. Further, they assert that each and every day between 2011 and 2030 10,000 baby boomers will turn 65. Currently, just 13% of Americans are age 65 or older, but by the time all of the Boomers have turned 65, 18% of the population will have reached retirement age. Notwithstanding that the average Boomer claims to feel 9 years younger than his or her chronological age, the tidal wave of aging Boomers will alter the economic and financial landscape in ways not yet contemplated by many people in wealth management (Pew Center, 2010).

Not a week goes by that we don't see an article in a newspaper, trade journal or web journal related to retirement. Most articles relay hearsay rules of thumb, or address a single dimension of the retirement equation in isolation, without regard for how changes in that dimension affect the other parts of the equation. This paper will address many of the heuristics, myths and misapprehensions that abound in the field of retirement planning by simulating the experience of retirees throughout history, and paying special attention to the co-integration of interest rates, equity returns, and inflation through time.

SAFE WITHDRAWAL RATES

At root, what retired or retiring investors care about is their Safe Withdrawal Rate (SWR). This rate represents the pre-tax amount that can be drawn from a portfolio each year, after adjusting for inflation. The amount is typically fixed in real terms as of the investor's retirement date, to allow retired persons to budget consistent income over time as if they were drawing from a fully indexed pension.

For example, imagine a couple retiring today with $1,000,000 in portfolio assets. They want to 'pensionize' (Milevsky, 2010) their nest egg by drawing a consistent annual income from their portfolio, and adjusting their income each year to account for inflation. The question is, how much can they safely withdraw? In technical parlance, they are interested in their Safe Withdrawal Rate, or SWR.

Often, a working couple is trying to discover how much money they need at retirement in order to generate enough income each year to maintain their lifestyle. A substantial part of the process involves optimizing their taxable situation by deciding which accounts to draw from and when (Huang and Milevsky, 2011), but once that is complete the couple is left with an amount they wish to draw pre-tax from their retirement portfolio. To answer this question, they need to know their SWR because their retirement savings target is equal to their pre-tax income needs divided by their SWR.

For example, a couple who needs $100,000 per year, pre-tax, to fund their lifestyle might discover that their SWR is 5%; they would then need $100,000 / 5%, or $2,000,000 in savings. If the couple's savings is (or is expected to be) below this number at retirement, the couple can pursue a variety of options to drive their equation back into balance. This paper will explore these options to identify how adjustments to retirement age, asset allocation, and preferences for longevity, market and failure risk impact the retirement equation, and offer methods for retirees to optimize their personal situation.

AFTCASTING

An examination of the body of literature on retirement planning yields a plethora of papers that propose complex, coherent and comprehensive actuarial frameworks for quantifying probable retirement outcomes. Unfortunately, most proposed approaches, even sophisticated ones, model the distribution of returns, interest rates and inflation independent of one another because it is very difficult to link these variables in randomized simulations like Monte Carlo (Finke, Pfau, and William, 2012). It turns out however that the relationships between these variables are very important, and can change dramatically over time and across market regimes. As a result, Monte Carlo and other approaches that treat these variables independently in simulation may be flawed.

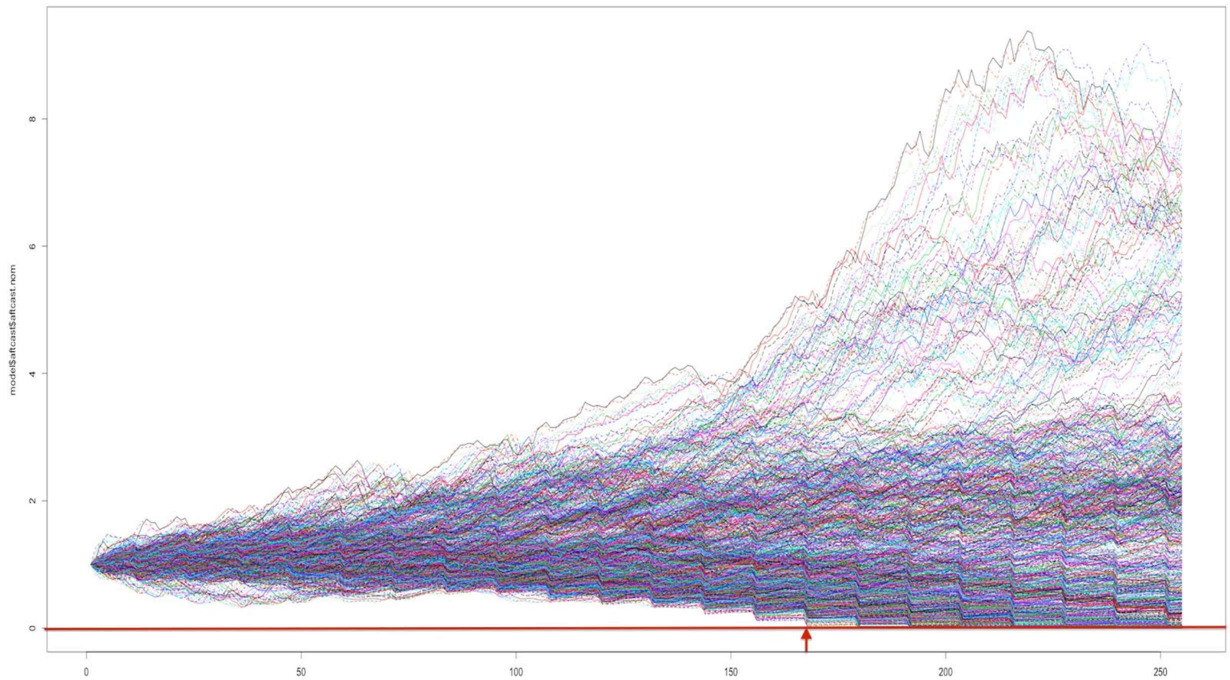
Jim Otar at Otar Retirement Solutions proposed that an analysis of actual market history was the most realistic model for retirement simulation, and called this process an Aftcast (Otar, 2012). The aftcast framework is perhaps uniquely suited to the problem of determining optimal SWRs because the framework successfully aggregates the feedback dynamics between equity returns, interest rates and inflation.

Aftcasts link actual investment returns and inflation results through time, which offers the most realistic snapshot of how retirees would have fared throughout history. While this method does not provide for the generation of 'alternative histories' through randomization, it does preserve the important relational dynamics between the three key variables described above. Further, with over 100 years of data, representing over 1300 months, we can still construct a wide variety of actual histories through time.

An aftcast quantifies the experience of many theoretical investors who each retire at the beginning of every month through history, and who live for a pre-determined period drawing income at a specified rate. For example, we might assume that the earliest investor in our simulation retired on Jan 1, 1900, after which he lived for 21.2 years (85th percentile lifespan for a 65 year old man) withdrawing the equivalent of 6% per year based on his starting portfolio value, and adjusting income each year for inflation using the realized CPI. We assume he was invested in some mix of U.S. stocks (S&P 500) and U.S. Treasuries, and model this retiree's experience to see if he succeeded in outliving his money. We then perform the same simulation assuming retirement on Feb 1, 1900 and track the outcome. Next we simulate the experience for a person retiring on March 1, 1900, and repeat this process for all rolling 21.2 year (254 month) periods through August 2012. Altogether, we generate almost 1100 actual 21.2-year retirement 'experiences' using realized historical monthly total return and inflation numbers.

If we were to plot the total portfolio values through time for all tests starting at month 1 and ending at month 254, the chart would look like Chart 1. All of the lines that touch the red ‘zero line’ at the bottom represent failed outcomes, because in those histories the portfolio ran out of money before the end of the 20 year retirement horizon. The red arrow at the bottom of the chart indicates how the least favorable histories ended with portfolio depletion after just 166 months.

Chart 1. Aftcast for 6% withdrawal rate, 60/40 stock/bond asset allocation, 21.2 year horizon



Source: Shiller, Federal Reserve

Portfolio paths ending above the line represent successes; in this case, which assumed a 60/40 stock/bond allocation, 77% percent of theoretical retirees were successful.

In other words, throughout the 112 years of history that we have for stocks, bonds and inflation,a 65-year-old man who withdrew 6% per year (of his portfolio's starting value) from a 60/40 portfolio, and adjusted withdrawals each year for CPI inflation, would have had a successful retirement 77% of the time. This 77% success rate represents the level of confidence that we might assume for this specific set of inputs going forward, holding all else constant. The next sections will explore how sensitive this confidence rate is to changes in these inputs.

THE 4 LEVERS OF RETIREMENT

The calculation of Safe Withdrawal Rates is impacted by four parameters that the investor controls:

- Age of retirement
- Investment risk tolerance
- Longevity risk tolerance
- Failure risk tolerance

AGE OF RETIREMENT

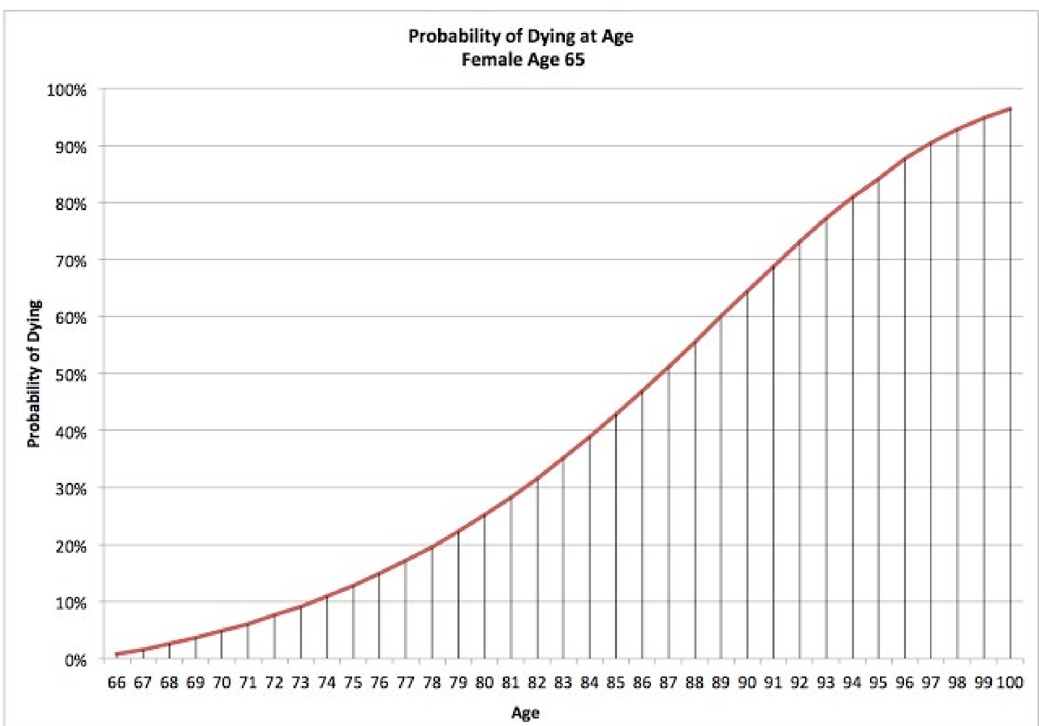
While some retirees are unable to control when they retire from their job because their employers mandate fixed retirement dates, many employees have a fair degree of control over when they want to retire, and those who don't can often find other gainful activity for some time after they retire from their job. To the extent that employees can control when they start drawing from their retirement savings, this is an important lever to consider in optimizing the retirement equation. Obviously, delaying full retirement has the benefit of reducing the number of years one will need to support themselves by drawing on their savings, but working a few more years also often means saving a few more years, and every dollar counts.

INVESTMENT RISK TOLERANCE

People tend to worry most about the investment risk of their retirement portfolio, which is just the risk of poor returns to the portfolio over the retirement investment horizon. This risk is generally managed by adjusting the asset allocation in portfolios. Portfolios with a higher percentage allocation to stocks are expected to have a higher return, but this exposure also carries higher risk.

This risk can impact retirees in two ways: first, a high exposure to equities carries a risk of large sustained losses that can have profound negative impacts on retirement sustainability, especially if the losses are incurred early on in the retirement horizon. Secondly, high volatility increases the risk of anxiety and emotional decision-making; investors have a habit of panicking at precisely the wrong time, and volatility amplifies this propensity dramatically. However, while the risks of overexposure to equities are important to understand, the risks of underexposure are no less grim. Investors with too little exposure to stocks risk portfolio growth that is too low to support inflation adjusted portfolio withdrawals. The question is, what is the right mix? We will answer this question below in the context of all the other related inputs.

Chart 2. Probability of dying, female age 65



Source: Statscan (2002)

LONGEVITY RISK TOLERANCE

Longevity risk is the risk of living longer, or less long, than is budgeted for in the retirement plan. More precisely, longevity risk is the risk associated with not knowing one's precise age at death. Obviously one's time until death can not be controlled in any meaningful sense, but the risk of death can be described in terms of the probability of dying at a certain age. For example, Chart 2. illustrates the probability of dying for a non-smoking 65 year old woman at subsequent ages. Observe that the red line crosses the 50% threshold at between age 86 and 87, indicating that 50% of women will die within about 22 years of turning 65.

Once the risk of death can be quantified at each age, it is possible to choose how confident one wishes to be about longevity. Given that a primary goal for many retirement plans is to sustain an income until death, retirees who wish to be very certain about not running out of funds might set their plan to an 85th or 90th percentile survival horizon (Huang and Milevsky, 2011). Using Chart 2. for females as a guide, a 90th percentile survival horizon might require a plan to age 97, while a 70th percentile plan would require planning to age 91. Clearly, if this theoretical retiree would be willing to accept a 70% longevity confidence rate rather than a 90% rate, she would budget for 6 fewer years of retirement, and this would allow her to withdraw more each year.

FAILURE RISK TOLERANCE

Lastly, retirees have some control over the amount of risk they are willing to take with their retirement outcome. This risk is quantified in our analysis by the percentage of periods through history where the assumptions used resulted in failed outcomes. In our example above that assumed a 21.2 year retirement horizon with a 60/40 portfolio, a 6% annual withdrawal rate, and a 0.5% annual fee, a retiree would be 77% confident of success. In our experience, retirees like to target a confidence rate of between 75% and 90%. Obviously, retirees who are willing to accept a higher risk of failure would be able to draw income at a higher rate.

PULLING ON THE LEVERS

Now that we have identified the four ways that retirees can control their retirement equation, the next step is to quantify how changes to these levers alter retirement outcomes. We have broken the analysis into two steps: first we will investigate what combinations of asset allocations and withdrawal rates have the highest rates of success. Then we will examine the probability of retirement success at different retirement ages and levels of longevity risk.

Chart 3. Percentage of successful outcomes over 20-year rolling horizons: asset allocation (top axis) vs. withdrawal rates (left axis)

			% Allocation to Equities (1-%= Allocation to Bonds)								
Withdrawal Rate* / **INDEX**	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
0.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
1.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
1.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
2.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
2.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
3.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
3.50%	99.19%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
4.00%	90.81%	98.92%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	99.73%	99.46%
4.50%	77.03%	86.76%	93.78%	96.49%	97.57%	98.92%	98.92%	98.92%	98.92%	98.11%	97.30%
5.00%	44.32%	62.16%	76.49%	85.68%	90.54%	91.62%	92.97%	93.51%	93.51%	92.43%	91.35%
5.50%	35.68%	43.78%	53.51%	65.14%	74.86%	79.46%	81.89%	83.24%	83.78%	83.24%	82.70%
6.00%	31.62%	35.41%	44.86%	52.16%	60.27%	67.30%	71.35%	73.51%	74.05%	74.59%	75.14%
6.50%	28.92%	30.00%	38.38%	43.78%	51.08%	55.95%	60.81%	64.59%	67.03%	67.57%	67.84%
7.00%	27.30%	27.30%	28.38%	37.30%	42.16%	48.11%	52.97%	57.30%	59.19%	62.97%	63.78%
7.50%	22.43%	25.95%	25.95%	29.46%	36.76%	40.81%	45.95%	48.92%	54.05%	55.41%	58.38%

* Includes .5% Annual Fee

Source: Shiller, Federal Reserve

Each cell in Chart 3. quantifies the percentage of successful outcomes through history at each equity allocation and withdrawal rate for a 20 year retirement horizon. Each cell represents a run of ~1100 possible retirement experiences over all rolling 240 month periods since 1900 with the specified assumptions. For example, the cell at the intersection of 60% across the top axis and 5% across the left axis quantifies the percentage of all 1100 'retirement experiences' through history where a retirement portfolio finished above zero with a 5% withdrawal rate and a 60/40 stock/bond allocation (92.97%). Note that we also applied 0.5% per year in fees, as this is (quite optimistically) the lowest cost an investor might have paid for access to this portfolio.

There are some important takeaways from this matrix. First, note that every asset allocation, even 100% Treasuries, has supported a 3% withdrawal rate, adjusted for inflation. Once withdrawal rates exceed 3%, adding some equities to the portfolio improves success ratios, but only up to a point. Rational investors with low levels of income requirements relative to the size of their retirement portfolio would therefore emphasize a very high bond allocation, as they can achieve the probability of success with less anxiety. This comes with a caveat, however; contemporary interest rates, at 1.8%, are lower than they have been at any time covered in our analysis. Therefore, investors with 100% bond positions today are unlikely to experience successful outcomes with 3% withdrawal rates.

The optimal mix of stocks/bonds for withdrawal rates between 3.5% and 5.5% inclusive seems to be about 70/30 or 80/20. Despite the much higher average return to equities vs. bonds over the past 112 years, retirement portfolios with reasonable withdrawal rates benefitted from some exposure to bonds because they reduced the magnitude and duration of equity bear markets, and reduced overall portfolio volatility.

Once withdrawal rates exceed 5.5%, retirement takes on more of a lottery character whereby successful outcomes are entirely dependent on above-average equity market returns; any allocation to bonds in this withdrawal range reduces the probability of success.

The next step is to determine how sensitive the retirement equation is to longevity risk. To investigate, we generated Chart 4., a matrix of retirement age versus percentile remaining lifespan. The percentile numbers across the top refer to the same concept discussed in reference to Chart 2. For example, from Chart 2. we can see that a woman retiring at age 65 who wants to budget to her 84th percentile lifespan would budget for 30 years of retirement (to age 95). In Chart 4. we have imputed the percentile remaining lifespan corresponding to each etirement age along the y axis.

Chart 4. Sensitivity of successful retirement outcomes to percentile of remaining lifespan vs. retirement age (assumes female life table,70% stocks/30% bonds, and 5% withdrawal rate)

				Percentile Remaining Lifespan								
	5%WR	70%	72%	74%	76%	78%	80%	82%	84%	86%	88%	90%
Retirement Age	50	56%	56%	56%	56%	56%	56%	55%	55%	55%	55%	53%
	52	59%	59%	58%	58%	57%	57%	57%	57%	57%	56%	56%
	54	63%	63%	63%	63%	60%	60%	60%	60%	60%	59%	59%
	56	69%	69%	66%	66%	66%	66%	66%	63%	63%	63%	63%
	58	74%	74%	72%	72%	72%	72%	72%	70%	70%	69%	69%
	60	77%	77%	77%	77%	77%	74%	74%	74%	74%	74%	72%
	62	82%	82%	82%	82%	82%	82%	78%	78%	78%	77%	77%
	64	88%	88%	88%	84%	84%	84%	84%	84%	82%	82%	82%
	66	91%	91%	91%	91%	91%	91%	88%	88%	88%	88%	88%
	68	95%	95%	95%	95%	95%	93%	93%	93%	93%	93%	91%
	70	99%	99%	97%	97%	97%	97%	97%	97%	95%	95%	95%

* Includes .5% Annual Fee

Source: Shiller, Federal Reserve

To interpret Chart 4., simply find your desired retirement age along the y-axis, and find your desired longevity confidence level along the top. The intersecting cell quantifies the percentage of historical 'retirement experiences' with successful outcomes with those assumptions. In keeping with our discovery (Chart 3.) that a 70/30 stock/bond allocation was optimal for a 5% withdrawal rate over 20 years, we assumed that allocation for the Chart 4. analysis. We also used female lifespan percentiles to be conservative (women outlive men on average), and a 5% withdrawal rate with 0.5% fee.

To draw an example from the chart, you can see that a person retiring at age 62 who wants to hedge 84% of longevity risk would have been successful 78% of the time through history with the assumptions above.

BUT I WON'T NEED AS MUCH INCOME WHEN I'M OLD

One objection to our standard retirement analysis that we hear all the time from clients is, "Why are you planning for me to maintain a stable income through retirement when I surely won't spend as much in my later years as I will in my early years." This point requires some discussion.

Wade Pfau recently presented a detailed exploration of this important dimension of the retirement planning equation in his paper, “How Do Spending Needs Evolve During Retirement (Pfau, 2012). As this topic is not central to the primary theme of this paper (individuals should discuss their specific situations with their planners), we have extracted Wade’s own words on the topic from his paper’s conclusion:

“So which is the better baseline assumption to use: constant inflation-adjusted spending or decreased spending as one ages? This is a big question that is still not fully resolved. We need to track individual households over time in order to better see the variety of spending patterns and how they relate to personal characteristics of the household. What percent of households voluntarily reduce their spending? What percent are forced to increase spending because one or more family member enters a nursing home or experiences large medical bills? Are personal characteristics linked to different spending patterns in such a way as could help advisors make better assumptions for their clients? For instance, higher net worth retirees may have much larger discretionary expenses when they enter retirement, while a more typical retiree may find that most of their spending is for essential needs, which will not decline and must adjust with inflation.

Spending may decline and I would not fault anyone for using assumptions of gradual real spending declines along of the lines of 10% or even 20% over the retirement period. But pending further research developments, I would avoid moving too far in the reduced spending direction as a baseline assumption. Though the standard assumption of constant inflationadjusted withdrawals *could be improved, it builds in reasonable conservatism and may not be too far off as a baseline. Applying differential inflation rates and age-based lifestyle adjustment factors, as in Basu's age-banding approach, may be the best approach for working with individual clients."*

Chart 5. Percentage of successful outcomes over 20 year horizon with 1 percentage point decrease in withdrawal after 10 years: asset allocation (top axis) vs. withdrawal rates (left axis)

Withdrawal Rate*		% Allocation to Equities (1-%= Allocation to Bonds)										
	INDEX	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	0.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	1.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	1.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	2.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	2.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	3.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	3.50%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	4.00%	99.19%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	99.73%
	4.50%	92.70%	99.19%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	99.73%	97.46%
	5.00%	75.95%	87.30%	94.32%	96.76%	97.84%	98.65%	98.65%	98.65%	98.38%	97.84%	96.76%
	5.50%	44.05%	60.81%	74.86%	84.32%	89.46%	90.81%	81.89%	92.16%	91.89%	91.35%	90.27%
	6.00%	35.14%	43.51%	53.24%	64.05%	72.70%	78.38%	80.81%	81.62%	81.89%	81.89%	81.08%
	6.50%	30.81%	33.24%	44.59%	51.08%	60.00%	65.41%	68.65%	71.08%	72.16%	72.70%	73.24%
	7.00%	28.65%	30.00%	36.22%	43.24%	49.73%	55.41%	60.54%	63.24%	66.22%	66.76%	67.03%
	7.50%	26.76%	27.30%	27.84%	36.22%	40.81%	47.03%	51.08%	55.41%	58.11%	61.35%	63.24%

* Includes .5% Annual Fee

Source: Shiller, Federal Reserve

Obviously, some retirees are willing to live with a much higher risk of humble lifestyle conditions in later life in order to 'live the adventure' in their early retirement years. To model this, we tested a program of reducing income rates by i percentage points every n years in retirement to see how this impacted retirement outcomes through history.

Chart 5. offers an example. Chart 5. is the same as Chart 3. except that we model a 1 percentage point reduction in spending every decade throughout the retirement horizon. In this case, the horizon is just 20 years, so the inflation adjusted income drawn in the second decade is 1 percentage point less than the income drawn in the first decade. If we tested a 30 year horizon,

Chart 5. Percentage of successful outcomes over 20 year horizon with 1 percentage point decrease in withdrawal after 10 years: asset allocation (top axis) vs. withdrawal rates (left axis)

		Percentile Remaining Lifespan										
	5%WR	**70%**	**72%**	**74%**	**76%**	**78%**	**80%**	**82%**	**84%**	**86%**	**88%**	**90%**
Retirement Age	50	86%	86%	86%	86%	86%	86%	86%	86%	85%	85%	85%
	52	87%	87%	87%	87%	87%	87%	87%	86%	86%	86%	86%
	54	89%	89%	89%	89%	88%	88%	88%	88%	88%	87%	87%
	56	92%	92%	90%	90%	90%	90%	90%	89%	89%	89%	89%
	58	93%	93%	92%	92%	92%	92%	92%	92%	92%	92%	92%
	60	94%	94%	94%	94%	94%	93%	93%	93%	93%	93%	92%
	62	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	94%
	64	97%	97%	97%	96%	96%	95%	95%	95%	95%	95%	95%
	66	98%	98%	98%	98%	98%	97%	97%	97%	97%	97%	97%
	68	100%	100%	100%	100%	100%	99%	99%	99%	99%	99%	98%
	70	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

* Includes .5% Annual Fee

Source: Shiller, Federal Reserve

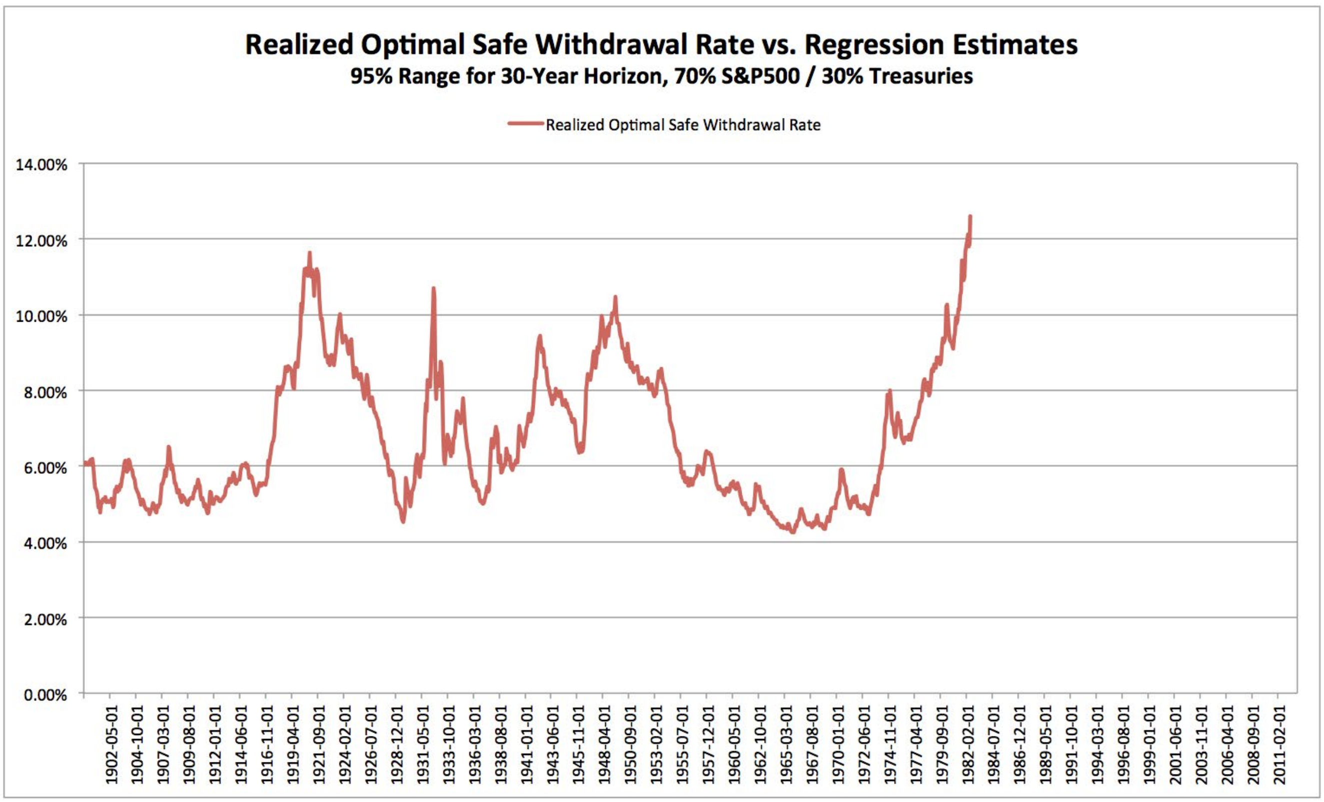
the 3rd decade would be subject to a 2 percentage point decline in income relative to the starting rate. If we compare results from the first matrix with those of the second matrix, you can see that, on average, retirees who decide to take 1% per year less in income in their second decade of retirement can budget for an extra 0.5 percentage points of income in their first decade with the same success rate. However, this math is not consistent once withdrawal rates exceed 5.5% or 6%; high withdrawal rates receive smaller incremental benefits from reducing income later in life because they are more sensitive to the effects of compounding.

Chart 6. repeats Chart 4. with the same income reduction after year 10. You can see that the income reduction does provide a meaningful reduction in longevity risk as well.

CONDITIONAL SAFE WITHDRAWAL RATES

Until now we have explored the subject of Safe Withdrawal Rates in the context of long-term market averages and percentiles without examining how interest rates and market valuation metrics might figure into the equation. In this section we will investigate the degree to which market valuation and interest rates at the beginning of retirement influence SWRs, and attempt to derive a conditional model to forecast SWRs given current valuation conditions.

Chart 7. Optimal withdrawal rate with perfect foresight, 360 month retirement horizon



Source: Shiller, Federal Reserve

This is not the first attempt to link SWRs with market valuation and interest rates. Pfau (2013) used the Shiller PE ratio, dividend yields, and contemporaneous interest rates to determine SWRs over a fixed retirement horizon of 30 years. His results, which should be interpreted as a warning shot for retirees, suggest SWRs under 2% at current rates and valuations, suggesting that current retirees would require over 50x their target pre-tax income to retire sustainably.

The first step involves reverse engineering the 'retirement experience' at each starting month through history to determine the precise withdrawal rate that would have resulted in total portfolio depletion on the last month of the retirement horizon. In other words, at each month through history we optimized the withdrawal rate using perfect foresight to fully deplete the portfolio on exactly the final month of retirement. (Note that this analysis does not include fees, so the numbers will not align with Charts 3 through 6). Our next step was to determine how we might be able to use contemporaneous market valuation estimates and interest rates to provide a better forecast for optimal withdrawal rates than the long-term average. Dr. Shiller's database provides Cyclically Adjusted Price to Earnings ratios back to 1881 for U.S. stocks, so we used this valuation metric as another input to our model. Lastly, we used the contemporaneous monthly Treasury rates since bonds are an important part of the overall equation.

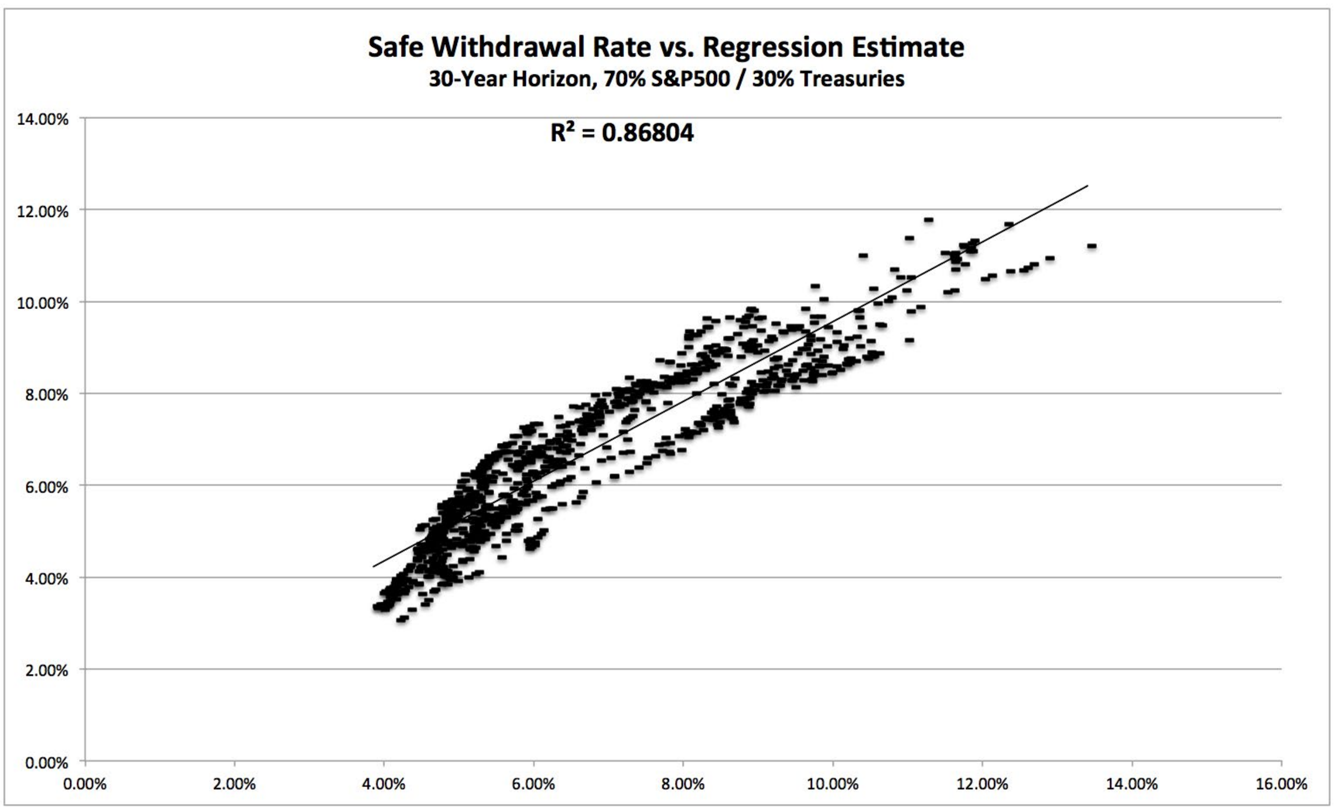
For several years we have performed a regular analysis of market valuation that uses a variety of fundamentally diverse valuation metrics to provide a statistical forecast for future stock market returns over long-term horizons (Butler, Philbrick, Gordillo, 2012)

Aside from the Shiller CAPE, our multi-factor analysis accounts for the Q-Ratio, total market capitalization to GNP, and deviations from the long-term price trends (Short, 2013). The Q-Ratio measures how expensive stocks are relative to the replacement value of corporate assets, while market capitalization to GNP accounts for the aggregate value of U.S. publicly traded business as a proportion of the size of the economy. In 2001, Warren Buffett wrote an article in Fortune where he states, "the ratio has certain limitations in telling you what you need to know. Still, it is probably the best single measure of where valuations stand at any given moment." Lastly, deviations from the long-term trend of the S&P inflation adjusted price series indicate how 'stretched' values are above or below their long-term averages.

These three measures take on further gravity when we consider that they are derived from four distinct facets of financial markets: Shiller PE focuses on the earnings statement; Q-ratio focuses on the balance sheet; market cap to GNP focuses on corporate value as a proportion of the size of the economy; and deviation from price trend focuses on a technical price series.

Taken together, they capture a wide swath of information about markets. We analyzed the power of each of these 'valuation' measures to explain inflation-adjusted stock returns including

Chart 8. Derived optimal withdrawal rate vs. multiple regression estimate from contemporaneous earnings yield and interest rate



Source: Shiller, Federal Reserve

reinvested dividends over subsequent multi-year periods.

When we regress the realized optimal withdrawal rates each month against the Shiller CAPE, Treasury yields and our own multi-factor valuation model, we are able to forecast safe withdrawal rates with very high accuracy. In fact, the forecast model generates an r-squared value of 0.868, which means that our three inputs explain 87% of the change in safe withdrawal rates through time. This is a very high level of explanatory power for a model of this nature, with the important caveat that the periods studied were necessarily overlapping, which substantially dilutes the formal statistical significance. Nevertheless, the very high explanatory power of this model lends a high degree of economic significance to the resultant forecasts.

The ANOVA analysis in Table 1. below provides us with the factor loadings, which allow us to generate forecasts from our three inputs. The table also provides factor ranges for the regression, which allows us to generate the 95% range around the forecast, which we illustrate graphically in Chart 9. Chart 9. shows the 95th percentile range of estimates for the safe withdrawal rate through

Table 1. ANOVA regression output

Regression Statistics	
Multiple R	0.931688435
R Square	0.868043339
Adjusted R Square	0.867647848
Standard Error	0.007338978
Observations	990

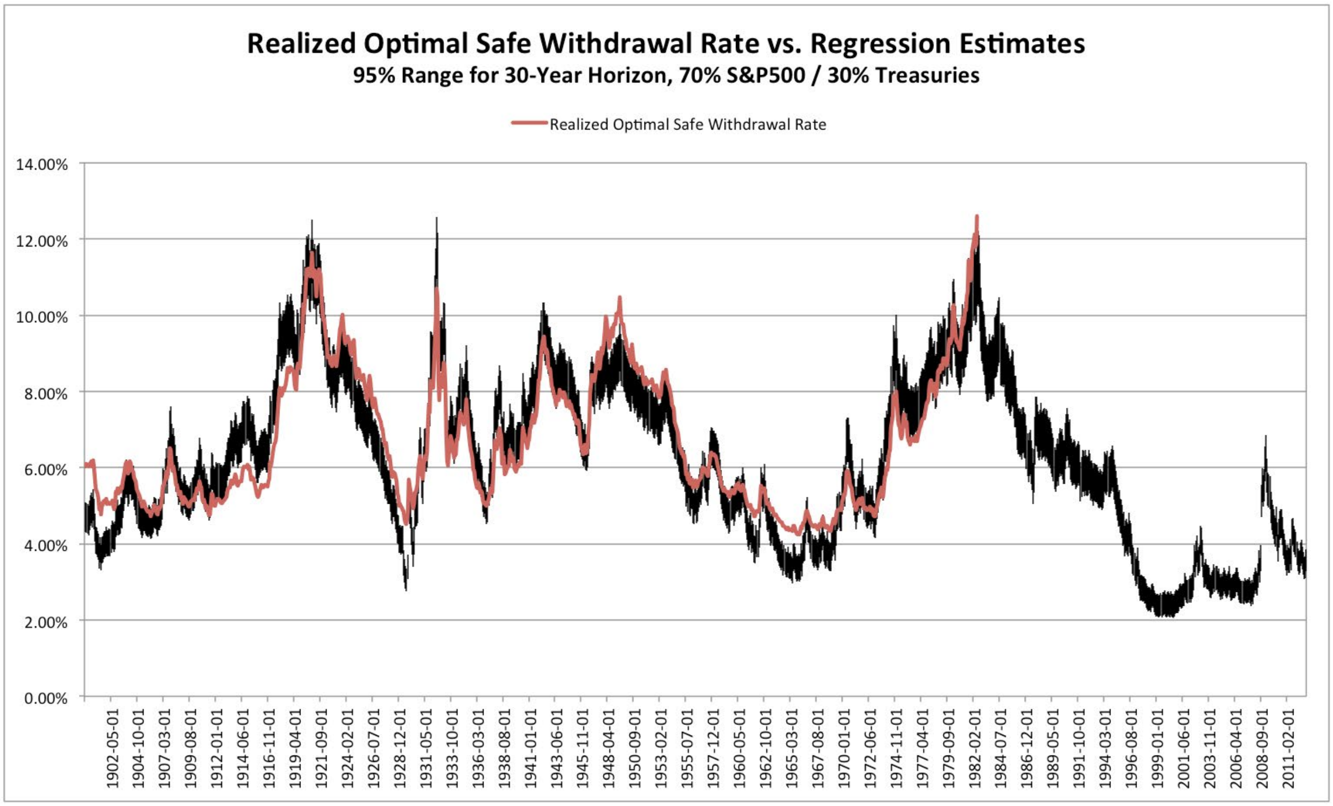
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0.349347948	0.116449316	2162.050094	0
Residual	986	0.053106552	5.38606E-05		
Total	989	0.4024545	0.402		

	Coefficients	*Standard Error*	*tStat*	*P-Value*	*Lower 95%*	*Upper 95%*	*Lower 85.0%*	*Upper 85.0%*
Intercept	0.015249414	0.000752505	20.26487274	1.3197E-76	0.013772719	0.016726109	0.014165315	0.016333513
Shiller CAPE	0.339462636	0.009841358	34.49347474	1.177E-171	0.320150222	0.35877505	0.325284647	0.353640625
10-Year Treasury Yield	0.072269064	0.011266535	6.414488749	2.18931E-10	0.050159921	0.094378207	0.056037888	0.08850024
Multi-Factor Forecast	0.323471405	0.0100089	32.31837591	7.6604E-157	0.303830211	0.3431126	0.309052046	0.337890765

Source: Shiller, Federal Reserve, Doug Short, Chris Turner, Standard & Poor's

Chart 9. The black region in the chart is the 95th percentile range of forecasts at each month based on the regression. The red line is the ex ante SWR.



Source: Shiller, Federal Reserve, Doug Short, Chris Turner, Standard & Poor's

time.

You can see that the regression model does a fine job of forecasting the safe withdrawal rate given contemporaneous stock market CAPEs, interest rates, and our own multi-factor return estimate model as inputs. You can also see that current estimates for optimal withdrawal rates are near the bottom end of the historical range: 3.28% - 3.87% to be specific. This shouldn't come as much of a surprise, since interest rates are near 220 year lows and earnings yields are in the top quintile of all monthly periods since 1871.

SUMMARY AND THOUGHTS

There is a great deal of contention about how to calculate safe withdrawal rates for the tsunami of retiring Boomers that will hit developed economies over the next 15 to 20 years. Many high quality studies have been conducted using Monte Carlo analysis, others through more sophisticated empirical methods, and still more through a purely analytical lens. The most comprehensive studies attempt to model the cointegration between interest rates, stock market returns and inflation, and it was our ambition to add more colour to this particular area of study.

We investigated the three primary sources of risk in retirement, and described a framework for quantifying these risks in a way that allows retirees to take control of their own risk/reward equation. Retirees face longevity risk, which is the risk of living longer (or less long) than expected; failure risk, or the risk of running out of money before death, and; market risk, which is the risk of poor investment returns over the retirement horizon.

We demonstrated how these risks are sensitive to the asset allocation between stocks and bonds, and proposed a model to quantify the optimal allocation given specified withdrawal rates and tolerance for failure. We also offered a model linking retirement age with longevity risk tolerance and tolerance for failure given specified asset allocations and withdrawal rates.

Unfortunately, most retirement planning is conducted under the potentially dangerous assumption of long-term average returns. Such assumptions manifest in amplified risk of plan failure as markets and interest rates often deviate from long-term average valuations for extended periods of time.

We examined the relationship between ex-ante safe withdrawal rates, and contemporaneous stock market valuations and long-term interest rates. A model was then proposed to estimate a statistically significant range of safe withdrawal rates given stock market valuations and interest rates at the month of plan inception, and it was determined that the model explained over 70% of changes to safe withdrawal rates over the 112 year study.

Investors that look to the above models for guidance must take account of the fact that fees and taxes may substantially reduce SWRs under all assumptions. As such, investors should speak to a qualified Advisor or planner who is well versed in actuarial retirement planning to see how the topics covered above affect their own personal situation. Further, given the sensitivity of safe withdrawal rates to initial valuation conditions, we are of the strong opinion that as markets approach high levels of valuation (e.g. high CAPE, low interest rates), investors would benefit from exploring alternative sources of return to complement, or perhaps even replace traditional investment approaches.

Finally, given that SWRs are especially vulnerable to periods of large or extended portfolio drawdowns, and that these types of drawdowns are much more likely to occur during periods of high market valuations. For these reasons investors might consider allocating to 'tactical alpha' strategies, which have historically managed to deliver stable returns across market regimes.

Examples of this type of approach include dynamic absolute valuation approaches (Butler, Philbrick, Gordillo, 2012), trend following (AQR, 2012), tactical asset allocation (Faber, 2009), robust risk parity, factor risk parity (AQR, 2012), generalized momentum (Keller, 2012), or adaptive asset allocation (Butler, Philbrick, Gordillo, 2012).

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