Mandating the Probability of Success: A New Approach to Retirement Planning

By John Barber and Dan Laimon

John Barber and Dan Laimon discuss their methodology that allows financial advisors to mandate a desired statistical probability for a successful retirement portfolio.

A successful retirement might be defined as not outliving one's assets. Today, the most important question advisors hear is not "How much will I earn on my portfolio?" but rather, "Am I going to have sufficient funds to take care of myself in my retirement?" Investors have other concerns, of course—leaving a legacy to children, charitable giving—but for most, the fundamental concern is being able to take care of themselves in their retirement.

Advisors can answer this question in a quantitative way. We would argue that the Probability Calculator may be more precise and more efficient than a sliding table or Monte Carlo simulations. At any rate, the Probability Calculator, discussed here, is a tool to consider when analyzing the chances of retirement portfolio success. The Probability Calculator quantifies the probability of a successful retirement from a portfolio, given an investor's portfolio value, age, gender, annual withdrawal, and asset allocation. By adjusting the model inputs, the probability of a successful retirement can be mandated.

Retirement risk is the probability of running out of money. Risk Capacity measures an investor's flexibility if the portfolio itself cannot entirely meet retirement objectives. Flexibility comes from the ability to lower the portfolio withdrawal rate and/or by accessing other assets to meet income needs. Investors with low risk capacity must aim for a high probability of retirement success from a portfolio; investors with high risk capacity can accept a lower probability because a shortfall in portfolio withdrawals can be supplemented elsewhere.

A Safe Retirement Process links the Probability Calculator to an investor's risk capacity, incorporating three important retirement planning factors: spending rates, uncertain returns, and uncertain mortality. The output is an asset allocation that provides the highest probability of achieving an investor's goals. This recommended asset allocation is then compared to the investor's measure of risk tolerance to determine if it is palatable. The asset allocation can be adjusted as long as the resulting probability of retirement success from the portfolio is appropriate. Although the subjective measure of risk tolerance has value in asset allocation, it is risk capacity that should drive the asset allocation decision. A minimum standard of 90 percent probability is the number we recommend for successful retirement, advocating a major shift in approach and implementation.

An Investment Policy Statement (IPS) Is Crucial

Traditionally, advisors write Investment Policy Statements (IPS) for their clients. An IPS serves to formally clarify portfolio objectives, establish an appropriate investment strategy, and derive a proper asset allocation. The IPS is a road map for the success of

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a portfolio. Without a defined written strategy, the portfolio is doomed to fail. We think the current industry-standard IPS contains some flaws, however, which we suggest can only be solved through the assessment of risk capacity.

Traditional IPS Shortfalls

Investors should know the statistical probability of a successful retirement from their portfolio assets. The traditional IPS fails to provide this information. Some financial advisors are reluctant to discuss probabilities in asset allocation modeling. They realize investors prefer to hear that they are going to be fine, their portfolios will grow each year, they can retire on schedule and they will not outlive their assets. That is acceptable if there is a near-100 percent certainty that the financial assumptions are correct. But what if they are not? A more realistic approach is the ability to project assumptions within a range of probabilities, such as 50 percent, 60 percent, etc., and deciding what percentage is acceptable, based on the availability of total resources.

An IPS typically includes the following components[1]:

- Return Requirements
- Risk Tolerance
- Investment Time Horizon

Return Requirements

Spending rates can be estimated with greater certainty than returns. To derive a return requirement, it is necessary to define an investor's income and expenses (Table 1). Classify the expenses as fixed or discretionary, and allow for a contingency (unanticipated expenses). For example, there are many retirees who live in Sarasota, Florida. Due to recent hurricanes, their home insurance premiums have increased 60 percent this year, and may skyrocket 200 percent next year. No one could have reasonably anticipated these additional expenses.

Table 1: Income & Expenses

Income	Expenses
Social Security	Fixed
Pension	Discretionary
Other	Contingency
Total Income	**Total Expenses**

Total income less total expenses equals the required portfolio withdrawal. Dividing the withdrawal by the portfolio value (measured as a percentage) renders the portfolio return requirement, used to derive an asset allocation. The return requirement remains accurate as long as the ratio of withdrawal to portfolio value remains constant from one year to the next. However, annual portfolio appreciation and withdrawal is rarely an exact match. The typical method for assessing return requirements and deriving an asset allocation is flawed because it does not allow for the potential loss of principal.

Suppose an investor with a $1 million portfolio needs $100,000 a year in retirement income and assumes a 10 percent annual return so that principal value is maintained (Table 2, Scenario 1). If the market experiences a 20 percent drop in the first year (Table 2, Scenario 2), the investor is hard pressed to recover, even if subsequent years have superior returns to push the average annual return to 10 percent. The Return Requirements component of a traditional IPS does not factor in the probability of sub-par annual investment returns.

Table 2: Income & Expenses

Scenario 1					
Year	Market Return	Portfolio Start Value	Portfolio Appreciation	Portfolio Withdrawal	Portfolio End Value
1	10%	$1,000,000	$100,000	($100,000)	$1,000,000
2	10%	$1,000,000	$100,000	($100,000)	$1,000,000
3	10%	$1,000,000	$100,000	($100,000)	$1,000,000
4	10%	$1,000,000	$100,000	($100,000)	$1,000,000
5	10%	$1,000,000	$100,000	($100,000)	**$1,000,000**
	Avg. Return:	10.00%			
Scenario 2					
Year	Market Return	Portfolio Start Value	Portfolio Appreciation	Portfolio Withdrawal	Portfolio End Value
1	-20%	$1,000,000	($200,000)	($100,000)	$700,000
2	20%	$700,000	$140,000	($100,000)	$740,000
3	15%	$740,000	$111,000	($100,000)	$751,000
4	27%	$751,000	$202,770	($100,000)	$853,770
5	15%	$853,770	$128,066	($100,000)	**$881,836**
	Avg. Return:	10.03%			

Risk Tolerance

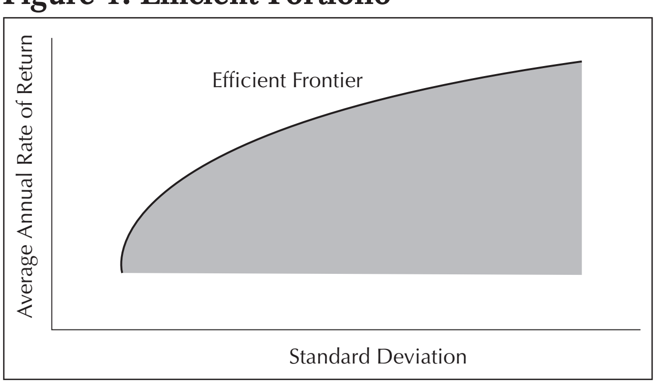
Risk tolerance describes an investor's ability to handle volatility. Most agree that over longer time horizons, stocks are likely to outperform bonds but have higher risk. Through discussion and questionnaires, advisors can assess an investor's risk tolerance in order to find a palatable asset allocation that can be maintained during inevitable market downturns. Table 3 illustrates some risk tolerance levels and corresponding asset allocations.

Table 3: Risk Tolerance Levels & Asset Allocation

Risk Tolerance	Percentage Stocks	Percentage Bonds	Risk as Measured by Portfolio Standard Deviation
Conservative	35%	65%	9.34%
Moderate	60%	40%	11.85%
Aggressive	80%	20%	14.32%
Very Aggressive	100%	0%	17.00%

Modern Portfolio Theory (MPT)[2] explains how to blend assets to produce efficient portfolios. An efficient portfolio is one that provides the greatest expected return for a given level of risk. The science of risk-efficient portfolios is associated with Nobel Laureates (awarded in 1990) Harry Markowitz and William Sharpe. As an example, take data for different portfolio weightings of stocks and bonds, and graph the return rates and standard deviations (risk). Markowitz showed that you get a region bounded by an upward-sloping curve, which he called the Efficient Frontier (Figure 1). For any given value of standard deviation, an investor would like to choose a portfolio that generates the greatest possible rate of return, a portfolio that lies along the efficient frontier rather than lower down in the interior of the region.

Figure 1: Efficient Portfolio



MPT has it's place in the analysis of the investor's portfolio and certain asset allocation considerations but it is our thought that it is flawed regarding retirement planning; it considers risk to be a portfolio's standard deviation of returns. Investors contemplating retirement, however, do not regard portfolio risk as the standard deviation of returns; they define risk as *the possibility of running out of money*! If retirement risk is the possibility of running out of money, why isn't that the focus of retirement planning? It should be.

Much as individuals prefer not to think about getting seriously ill, they may not want to hear that based on their perception of risk tolerance, there is only a 60 percent chance of reaching their financial objectives. Gaining that knowledge as a result of assessing risk capacity in tandem with the Probability Calculator provides a clearer and more realistic picture of an investor's true financial condition. Unlike the way risk tolerance is addressed in a traditional IPS, this approach provides the best asset allocation decision to achieve a successful retirement.

Investment Time Horizon

Investment time horizon is a major factor in determining if an investor can retire. Longer time horizons may require higher returns to sustain a constant quality of life. Clients retire at different ages: Those who enjoy working may continue into their 70s or 80s while others may wish to retire as early as their 50s.

Medical advances are increasing life expectancy and the number of years investors will be retired. According to Social Security Administration calculations,[3] the life expectancy of a 60 year-old female is 82.53 years and half can expect to live past that age. Each passing year increases an individual's life expectancy. A 65 year-old female has a life expectancy of 83.83 years. A 70 year-old female has a life expectancy of 85.39 years.

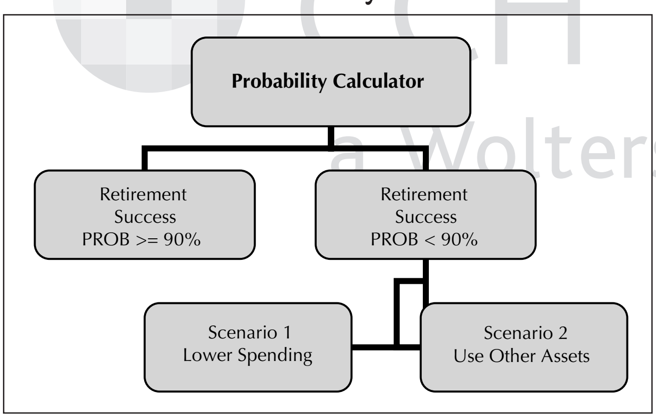
As age increases, the median age at death also increases. In other words, the probability of survival is conditional, not constant. This uncertainty should be a vital component of retirement planning and the model must incorporate these conditional probabilities. Most investors do not want to gamble on the prospect of outliving their assets. Updated life expectancy should be part of the investment time horizon calculation. The Probability Calculator incorporates updated life expectancy (conditional probabilities of survival) as the investor ages while a traditional IPS investment time horizon assumption does not.

Risk Capacity Assessment Provides a Realistic Picture

Risk capacity measures an investor's flexibility should the portfolio alone not fully meet retirement objectives. Flexibility comes from the ability to lower the portfolio withdrawal rate and/or access other assets to meet income needs. Risk capacity measurement is critical because it factors in what might happen if the investor suffers principal losses. Does the investor have the flexibility to adjust to a lower portfolio value or withdrawal rate, and if so, by how much? This level of flexibility (risk capacity) dictates the appropriate target range for the required probability of retirement success from the portfolio.

Retirement is "successful" if the investor's portfolio does not run out of money while he or she is still alive. The key issue for retirement planning should be to mandate a minimum 90 percent probability for a successful retirement. If the probability of a successful retirement is 90 percent or greater from the portfolio assets alone, the investor will likely be fine. If the probability is less than 90 percent, the probability should be raised to the 90 percent level through other means. Can the investor's spending rate be lowered to raise the probability to at least 90 percent? If not, are there outside sources of income available to raise the probability level?

BarberLaimon Probability Calculator.



With the help of the Probability Calculator, the likelihood of a successful retirement can be easily calculated. Investors can mandate their precise desired probability of retirement success, and conclude a sustainable withdrawal rate and best asset allocation.

Moshe Milevsky and Chris Robinson recently published an article titled, "A Sustainable Spending Rate without Simulation".[4] In it, the authors discuss a concept called "Stochastic Present Value" and created a statistical model framework for assessing the probability of a successful retirement. The model accounts for the uncertain ("stochastic") values of investment returns and time horizon (mortality), and is the foundation of the Probability Calculator. Three probability distributions,[5] five assumptions regarding stock and bond returns,[6] and an expected inflation rate[7] are integrated within the Probability Calculator to allow it to define the probability of a successful retirement.

The investor enters four inputs into the Probability Calculator (Table 4). These inputs are unique to each investor, and only one of these inputs (income requirement) takes some effort to derive.

Table 4: Probability Calculator Inputs

Required Data	Input
Gender (M or F)	M
Current Age	75
Income Requirement	$80,000
Portfolio Value	$1,385,000

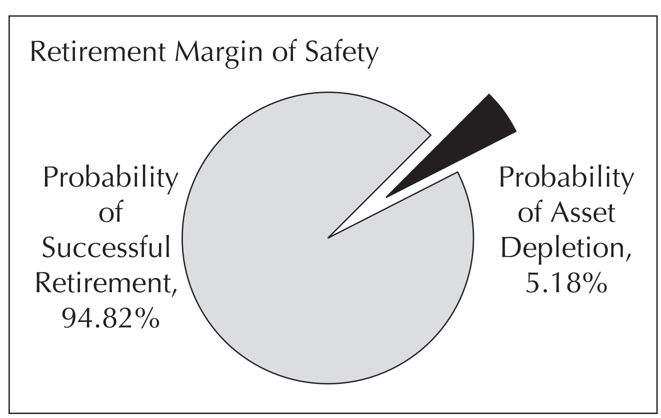
Seven Steps to the "Safe Retirement Process"

There are seven steps to reach a desired statistical probability of successful retirement from an investment portfolio, as well as the optimal asset allocation decision. The steps:

1. The investor's income and expenses are defined (Table 1), necessary to derive an accurate estimated annual withdrawal from the portfolio.
2. The four required data inputs are entered into the Probability Calculator (Table 4), providing two outputs. The *Retirement Margin of Safety* (Figure

Figure 2: Retirement Margin of Safety

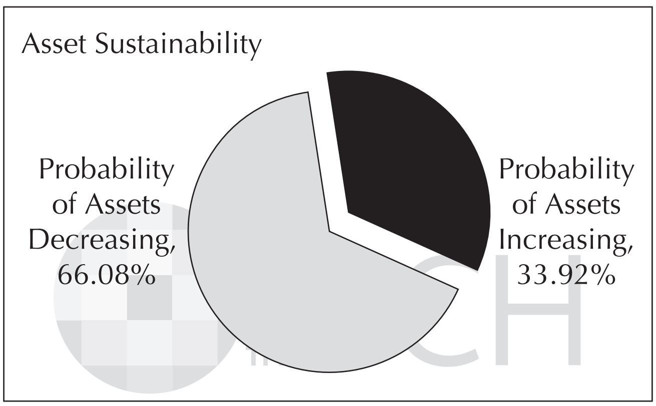
Recommended Asset Allocation	
Stock Weight	80.00%
Bond Weight	20.00%
Portfolio Risk (St. Dev)	13.67%
Probability of Successful Retirement	94.82%
Probability of Asset Depletion	5.18%



2) indicates the asset allocation that will provide the highest probability of a successful retirement. Given this asset allocation, the *Asset Sustainability* (Figure 3) provides the probability of the portfolio increasing its principal value over an infinite time frame (perpetuity). Of these two outputs, the *Retirement Margin of Safety* is more important.

Figure 3: Asset Sustainability

Recommended Asset Allocation	
Stock Weight	80.00%
Bond Weight	20.00%
Portfolio Risk (St. Dev)	13.67%
Probability of Assets Increasing	33.92%
Probability of Assets Decreasing	66.08%



3. If the *Retirement Margin of Safety* output determines that the indicated probability of a successful retirement is 90 percent or greater, proceed to Step 5. If not, go to Step 4.
4. If the *Retirement Margin of Safety* output (probability of a successful retirement) falls short of 90 percent, can the investor's discretionary expenses be lowered? If not, assets outside the portfolio should be considered. Set the income requirement in the Probability Calculator to an amount that generates a minimum 90 percent *Retirement Margin of Safety.* This amount will be less than the investor's actual income requirement, but is the amount that is feasible to withdraw from the portfolio and meet the mandate. Investigate if the shortfall (the actual income requirement less the amount that can be withdrawn from the portfolio) can be accessed through other assets. Once the *Retirement Margin of Safety* output is 90 percent or greater, go to Step 5.
5. The stock weight in the *Retirement Margin of Safety* output can be manually adjusted. At first, the output will be the stock weight that maximizes the probability of a successful retirement. However, the final asset allocation decision need not correspond to the maximum probability of success; rather, it needs to fall within the target probability of success. The investor can (and should) test different levels of stock weight to see a range of output. This discloses how the investor can mandate a desired statistical probability from the portfolio. Perform a quick sensitivity analysis regarding different levels of stock weight until the desired probability is achieved.

   It is interesting to note that the probability of a successful retirement is more sensitive to the portfolio withdrawal rate than the asset allocation. Once an asset allocation has been tentatively concluded, proceed to Steps 6 and 7 (risk tolerance assessment). These steps are two final checks to ensure an investor's risk tolerance is palatable with the asset allocation decision derived from the investor's risk capacity assessment.

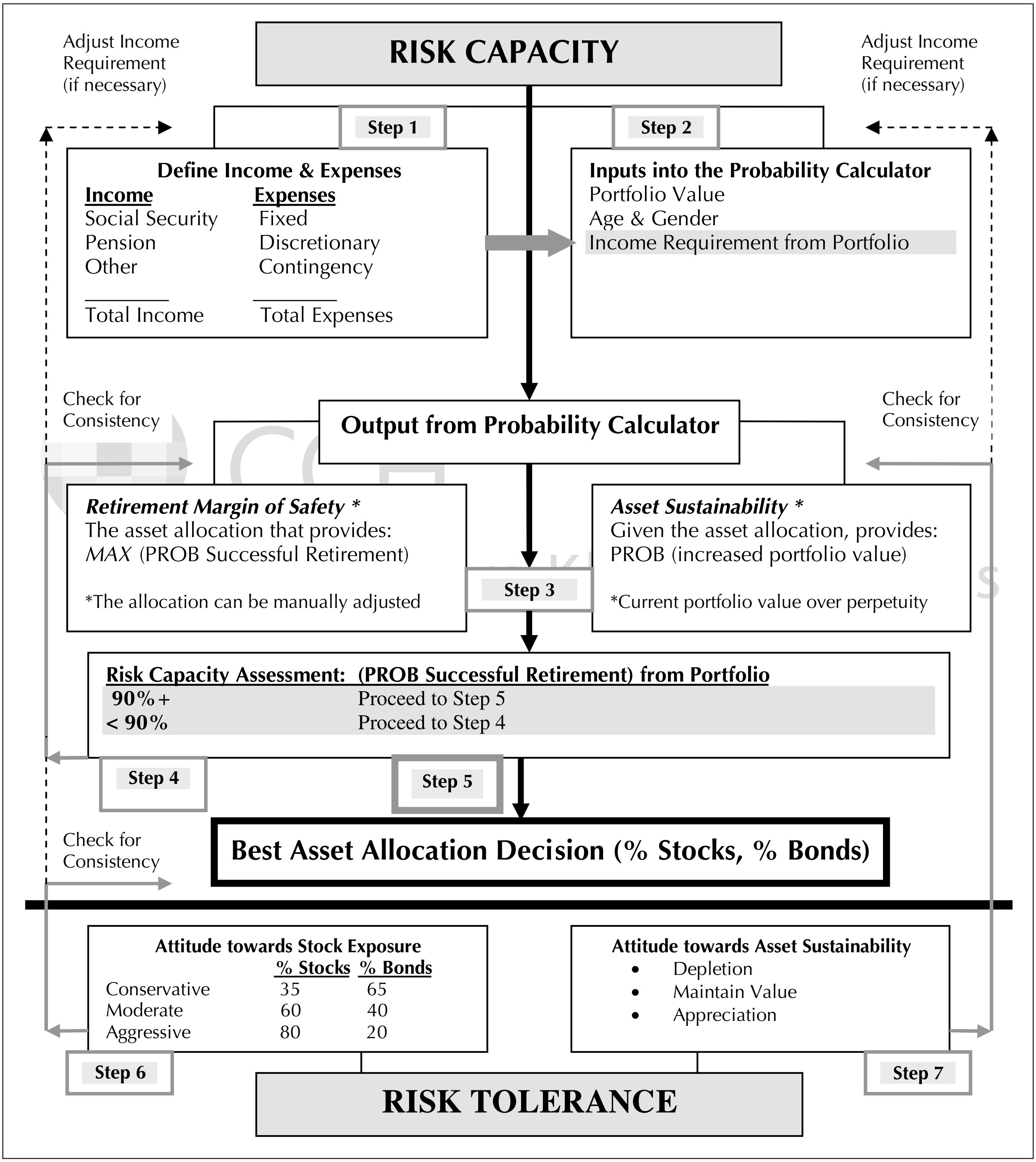
   Notice that investor risk tolerance does not drive the asset allocation decision. In fact, risk tolerance is not considered until a tentative asset allocation decision has been reached. This is contrary to most current retirement planning methodologies and practices. As previously stated, it advocates a quantum shift in approach and implementation.
6. As part of an investor's risk tolerance assessment, consider the investor's attitude towards stock exposure (Table 3). Is the investor conservative, moderate, or aggressive? How does this attitude (and its corresponding range of stock weight) compare with the tentatively concluded level of stock weight in step 5?

   If the asset allocation (stock weight) decision in Step 5 is consistent with the investor's attitude towards stock exposure, go to Step 7. If inconsistent, the investor must change his or her stock attitude, accept the concluded stock weight despite misgivings, adjust the withdrawal rate, or draw upon other assets (go back to Step 1).
7. Recall that the *Asset Sustainability* output (Figure 3) provides the probability of the portfolio increasing its inflation-adjusted principal value over perpetuity. Check to ensure that this data is consistent with the investor's attitude towards asset sustainability.

   If the *Asset Sustainability* output is consistent with the investor's attitude, the best asset allocation decision has been reached. If inconsistent, the investor must change his or her attitude towards asset sustainability, accept the concluded stock weight despite misgivings, adjust the withdrawal rate, or draw upon other assets (go back to Step 1).

The seven steps to the "Safe Retirement Process" are depicted in Figure 4.

Figure 4: Seven Easy Steps to the "Safe Retirement Process"



Example 1

Mike Smith is 62 years old and has been forced into early retirement. His portfolio value is $1,200,000, and he estimates his annual withdrawal from the portfolio at $80,000.

Mr. Smith has $250,000 equity in his home but does not have other assets in case of an emergency.

He mandates a 90% target probability of a successful retirement. Mr. Smith is not comfortable with 100% stock exposure.

RISK CAPACITY

i) Probability Calculator	Inputs
Portfolio Value	$1,200,000
Gender (M or F)	M
Current Age	62
Annual Withdrawal (Anticipated)	$80,000

ii) Other Assessment

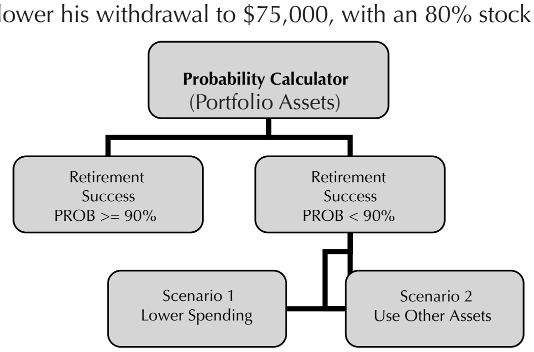
Target Range (Prob. Success)	90%+
Mandate (Prob. Success)	90%

RISK TOLERANCE

Attitude: Stock Exposure	MODERATE
Attitude: Asset Sustainability	MAINTAIN

DECISION

At an $80,000 withdrawal, Mr. Smith needs 100% stock weighting to approach his mandated probability of retirement success (90%). He is not comfortable with this. Instead, he decides to lower his withdrawal to $75,000, with an 80% stock weighting.



OUTPUT

Annual Withdrawal = $80,000

Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	89.08%	30.63%
90.00%	10.00%	88.69%	27.74%
85.00%	15.00%	88.39%	26.02%
80.00%	20.00%	88.02%	24.11%
75.00%	25.00%	87.56%	22.02%
70.00%	30.00%	87.01%	19.77%
65.00%	35.00%	86.38%	17.38%
60.00%	40.00%	85.64%	14.90%

OUTPUT

Annual Withdrawal = $75,000

Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	90.65%	35.43%
90.00%	10.00%	90.37%	32.74%
85.00%	15.00%	90.13%	31.10%
80.00%	20.00%	89.83%	29.23%
75.00%	25.00%	89.46%	27.14%
70.00%	30.00%	89.00%	24.83%
65.00%	35.00%	88.47%	22.32%
60.00%	40.00%	87.84%	19.63%

OUTPUT

Annual Withdrawal = $90,000

Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	85.63%	22.49%
90.00%	10.00%	85.00%	19.47%
85.00%	15.00%	84.56%	17.77%
80.00%	20.00%	84.03%	15.95%
75.00%	25.00%	83.39%	14.05%
70.00%	30.00%	82.62%	12.09%
65.00%	35.00%	81.79%	10.13%
60.00%	40.00%	80.81%	8.21%

Example 2.

Julie Jones is 58 years old and wants to determine if she can retire. She has a portfolio value of $2,000,000 and estimates her annual withdrawal requirement from the portfolio at $130,000.

Ms. Jones has refinanced her home and has $150,000 equity value. She has minimal emergency assets.

She mandates a 90% target probability of a successful retirement. Ms. Jones is not comfortable with 100% stock exposure.

RISK CAPACITY

i) Probability Calculator	Inputs
Portfolio Value	$2,000,000
Gender (M or F)	F
Current Age	58
Annual Withdrawal (Anticipated)	$130,000

ii) Other Assessment

Target Range (Prob. Success)	90%+
Mandate (Prob. Success)	90%

RISK TOLERANCE

Attitude: Stock Exposure	MODERATE
Attitude: Asset Sustainability	MAINTAIN

DECISION

Ms. Jones cannot afford to retire at this time. Even with a 100% stock weighting, which she cannot tolerate, she has a 1 in 8 chance of asset depletion. She uses the Calculator and finds that if her portfolio appreciates 20% in four years (to $2,400,000) she can retire with a 75% stock weight.

	OUTPUT		
Annual Withdrawal = $130,000			Age: 58
Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	87.89%	32.49%
90.00%	10.00%	87.49%	29.67%
85.00%	15.00%	87.16%	27.97%
80.00%	20.00%	86.74%	26.07%
75.00%	25.00%	86.21%	23.98%
70.00%	30.00%	85.56%	21.69%
65.00%	35.00%	84.79%	19.24%
60.00%	40.00%	83.89%	16.67%
$2,000,000	Portfolio	Value	

	OUTPUT		
Annual Withdrawal = $135,000			Age: 60
Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	89.84%	36.82%
90.00%	10.00%	89.56%	34.21%
85.00%	15.00%	89.31%	32.59%
80.00%	20.00%	88.97%	30.75%
75.00%	25.00%	88.55%	28.67%
70.00%	30.00%	88.04%	26.36%
65.00%	35.00%	87.42%	23.83%
60.00%	40.00%	86.68%	21.11%
$2,200,000	Portfolio	Value	

	OUTPUT		
Annual Withdrawal = $140,000			Age: 62
Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	91.41%	40.70%
90.00%	10.00%	91.20%	38.32%
85.00%	15.00%	91.00%	36.81%
80.00%	20.00%	90.74%	35.06%
75.00%	25.00%	90.41%	33.05%
70.00%	30.00%	89.99%	30.78%
65.00%	35.00%	89.49%	28.24%
60.00%	40.00%	88.89%	25.44%
$2,400,000	Portfolio	Value	

Example 3.

Edward Chan is 75 years old and retired. He has a portfolio value of $3,000,000. He has been taking $240,000 from the portfolio and wants to know the feasibility of taking at least $300,000 so he and his wife can travel. The legacy (assets) to be left to his three children is not a major concern.

Mr. Chan has a $900,000 vacation home that will be sold within two years. He also has emergency assets if needed. These other assets can easily raise his probability of a successful retirement above 90%. He mandates a 78% target probability of a successful retirement from the portfolio. Mr. Chan is not comfortable with high stock exposure.

RISK CAPACITY

i) Probability Calculator	Inputs
Portfolio Value	$3,000,000
Gender (M or F)	M
Current Age	75
Annual Withdrawal (Anticipated)	$240,000

ii) Other Assessment

Target Range (Prob. Success)	90%+
Mandate (Prob. Success)	78%

RISK TOLERANCE

Attitude: Stock Exposure	MODERATE
Attitude: Asset Sustainability	DEPLETION

DECISION

If Mr. Chan continues his $240,000 portfolio withdrawals, he has enormous flexibility regarding stock weight. If he wants to withdraw $300,000, a stock weight as low as 65% is consistent with the mandated probability.

OUTPUT

Annual Withdrawal = $240,000

Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	89.40%	18.49%
90.00%	10.00%	88.98%	15.54%
85.00%	15.00%	88.70%	13.93%
80.00%	20.00%	88.38%	12.25%
75.00%	25.00%	88.00%	10.54%
70.00%	30.00%	87.58%	8.83%
65.00%	35.00%	87.10%	7.16%
60.00%	40.00%	86.56%	5.60%

OUTPUT

Annual Withdrawal = $300,000

Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	82.53%	7.92%
90.00%	10.00%	81.70%	5.82%
85.00%	15.00%	81.18%	4.81%
80.00%	20.00%	80.60%	3.86%
75.00%	25.00%	79.95%	2.98%
70.00%	30.00%	79.23%	2.21%
65.00%	35.00%	78.45%	1.56%
60.00%	40.00%	77.60%	1.04%

OUTPUT

Annual Withdrawal = $320,000

Stock %	Bond %	Probab. Successful Retirement	Probab. Increased Assets (perpetuity)
100.00%	0.00%	80.00%	5.85%
90.00%	10.00%	79.01%	4.10%
85.00%	15.00%	78.41%	3.29%
80.00%	20.00%	77.74%	2.55%
75.00%	25.00%	77.00%	1.89%
70.00%	30.00%	76.18%	1.34%
65.00%	35.00%	75.30%	0.90%
60.00%	40.00%	74.34%	0.57%

Conclusion

Risk capacity assessment is a key to successful retirement. It allows investors to mandate a desired statistical probability that they will not run out of money during their lifetime. This should be considered the most important component of portfolio risk control. The key issue for retirement planning should be to mandate a minimum 90 percent probability for a successful retirement.

The assessment should be revisited on an annual basis as an investor's financial needs may change from one year to the next. At the very least, two of the required data points for the Safe Retirement Process (age and portfolio value) will change. Updated Probability Calculator inputs may indicate a need to adjust an investor's portfolio asset allocation, as might a change in the investor's risk capacity assessment. The goal is to maintain the mandated statistical probability of retirement success.

We believe currently adopted retirement planning techniques, such as standard investment policy statements, sliding tables and Monte Carlo simulations, are incomplete tools. We also believe the Nobel prize-winning (1990) Modern Portfolio Theory (Markowitz & Sharpe) is no longer the best and only foundation for safeguarding retirement funds. Risk capacity should drive the appropriate asset allocation decision. The Safe Retirement Process links three vital elements in retirement planning: spending rates, uncertain returns and uncertain mortality. The output of these factors is a model-generated asset allocation that precisely defines the probability of achieving the investor's goals. Gaining this knowledge provides investors with a much clearer and more realistic picture of their true financial condition.

> Risk capacity assessment is a key to successful retirement. It allows investors to mandate a desired statistical probability that they will not run out of money during their lifetime.

We have not addressed taxes in this article. The Probability Calculator can also consider an investor's tax considerations in deriving the best retirement strategy.

The Probability Calculator can be accessed on the TriVant website: *http://www.trivant.com*. Readers can enter data and calculate the likelihood of a successful retirement. The proprietary model will also generate a range of probabilities, based on different asset allocations.

Endnotes

1. JOHN W. PEAVY III, CFA, KATRINA F. SHERRERD, CFA, CASES IN PORTFOLIO MANAGEMENT, AIMR (1991).
2. Modern portfolio theory (MPT)—or portfolio theory—was introduced by Harry Markowitz with his paper *Portfolio Selection*, which appeared in the 1952 J. FINANCE. Thirty-eight years later, he shared a Nobel Prize with Merton Miller and William Sharpe for what has become a broad theory for portfolio selection.
3. Life Expectancy is calculated as a function of current age and gender, and is derived from data provided by the Social Security Administration.
4. Moshe A. Milevsky and Chris Robinson, *A Sustainable Spending Rate without Simulation*, FINANCIAL ANALYSTS J., November/December 2005.
5. The three important probability distributions are the Lognormal Random Distribution, Exponential Lifetime Distribution, and Reciprocal Gamma Distribution.
6. Expected stock return = 10 percent; Expected stock risk (standard deviation) = 17 percent; Expected bond return = 6 percent; Expected bond risk (standard deviation) = 8 percent; Expected correlation (stocks and bonds) = 0.4.
7. Expected inflation = 3 percent.