

# Sufficient Income and Sustainable Withdrawal Rates for Retirement

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## Abstract

Since the passage of the Employee Retirement Income Security Act of 1974 (ERISA), numerous companies from throughout the United States have chosen to change from providing “Defined Benefit” pension plans to providing “Defined Contribution” pension plans. Issues with underfunding and increasing longevity caused the Defined Benefit to Defined Contribution switch. Now, successful retirement planning is an iterative process that requires the management of many variables. Some are random and unpredictable in scope and magnitude and others are choices we make as our retirement objectives change. It’s essential that changes be incorporated expeditiously to minimize adverse outcomes. One can begin the process by estimating the annual income required to support one’s “retirement lifestyle” if retirement occurred today. Then extrapolate that income to the planned retirement date based upon the expected rate of inflation. A “modified four percent rule” can then be used to estimate the portfolio value required to support 30 or more years in retirement. The financial planner and client should go through this process at least every two years or when major events suggest a change is required. To assist the planner, this paper extends the Four Percent Rule in the following ways: Time in retirement is 16 – 40 years in 2-year increments with an asset allocation range is 0% to 100% stocks in 15 equal steps. Three auxiliary tables (Panels A, B, & C) are provided to facilitate the iteration process.

## I. Introduction

The passage of the Employee Retirement Income Security Act of 1974 (ERISA) set the stage for changes in the provision for retirement for individual workers. ERISA requires retirement plans to provide participants with plan information including important information about plan features and funding; sets minimum standards for participation, vesting, benefit accrual and funding; provides fiduciary responsibilities for those who manage and control plan assets; requires plans to establish a grievance and appeals process for participants; gives participants the right to sue for benefits and breaches of fiduciary duty; and, if a defined benefit plan is terminated, guarantees payment of certain benefits through a federally chartered corporation, known as the Pension Benefit Guaranty Corporation (PBGC).<sup>1</sup> Additionally, the Revenue Act of 1978 included a provision that became Internal Revenue Code (IRC) Sec. 401(k) (for which most Defined Contribution Plans are named), under which employees are not taxed on the portion of income they elect to receive as deferred compensation rather than as direct cash payments.<sup>2</sup>

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<sup>1</sup> Source: United States Department of Labor

<sup>2</sup> Public Law 95-600—November 6, 1978, 95<sup>th</sup> Congress of the United States of America

The above referenced Revenue Act added permanent provisions to the IRC, sanctioning the use of salary reductions as a source of plan contributions. The law went into effect on Jan. 1, 1980. Regulations were issued in November of 1981. Using the above provisions, numerous companies from throughout the United States chose to establish “Defined Contribution” pension plans and discontinue the provision of “Defined Benefit” pension plans. Under the defined benefit plan, participants were not concerned about withdrawing too much from their plan in the early years leaving them with a shortfall in funding at the end of their life. Providing their Defined Benefit Plan was sufficiently funded by the company for whom they had worked for many years, the participant was guaranteed a life annuity, possibly with survivor benefits for the participants’ spouse. Issues with underfunding and increasing longevity, along with the aforementioned statutory changes, resulted in the Defined Benefit to Defined Contribution switch. Additionally, decreasing loyalty to one company and movement by members of the workforce to several different employers over the course of a career increased the attractiveness of Defined Contribution Plans. However, as participants in Defined Contribution plans approach retirement, the owner of the plan is faced with determining the appropriate rate of withdrawal. Each plan participant must continually answer the following two questions: (1) “Based upon my existing portfolio, my current income, and the risk that I am willing to take, what percentage (or amount) of my current income should I invest to reach the desired portfolio value so that I can have my desired income level in retirement?” and (2) “While in retirement, what proportion may I withdraw from my portfolio each year to ensure that I will have sufficient funds to provide for my needs for retirement that lasts for an uncertain period?”

A last and fundamental question: “Given my current age, what is my (and my spouse/partner) remaining life expectancy.” Drawing on the Life Expectancy Calculator available on the Social Security Administration website, the life expectancy of a child born on January 1, 2020 is approximately 85 years.<sup>3</sup> An individual attaining age 40 in 2020 can expect to live an additional 43.5 years or to age 83.5 years. One reaching the earliest SSA retirement age of 62 may expect to live to be 84.8 years old. If retirement is chosen at full SSA retirement age (66 years in 2020), the individual may expect to reach the age of 86.3 years. Finally, one who retires at age 70 may expect to reach the age of approximately 85.5 years.<sup>4</sup> These age expectancies are averages indicating that fifty percent of those attaining the listed life expectancy will live longer. Of course, how much longer is unknown.

Retirement planning is an iterative process that attempts to keep one on a trajectory leading to a successful retirement. Several analytical approaches are available for estimating one’s desired inflation adjusted annual income in retirement.<sup>5</sup> Retirement planners (Financial Planners and individuals) should then use this information to estimate the value of a portfolio that will produce the desired annual income for an appropriate number of years (life expectancy) and determine the **savings profile** that will achieve the income goal. Of course, there are challenges to this process. The planner faces an uncertain future that may change significantly over time. Changing employment opportunities, illnesses, lifestyle desires, unplanned obligations, unexpected monetary gains or losses, tax rates and regulations are examples. Most Financial Planners agree that financial plans should be reviewed at least every two years or when

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<sup>3</sup> See <https://www.ssa.gov/planners/lifeexpectancy.html>

<sup>4</sup> The average age attained is computed as a simple average of the life expectancy of male and female at each age attained in 2016 added to the age attained that year.

<sup>5</sup> Please see Appendix 1 for a discussion of how this paper adjusts for inflation.

significant life changes occur. Doing so provides information and understanding to adjust early to minimize the magnitude of necessary changes. This paper proposes an adaptive process that uses historical data to estimate future portfolio and income values and sustainable withdrawal rates from *Defined Contribution* based retirement portfolios over reasonable retirement (life expectancy) horizons. The next section considers the approach taken in recently published literature. Section III presents the methods used to establish retirement portfolios and sustainable withdrawal rates from those portfolios. Section IV discusses simulations that provide information concerning sustainable withdrawal rates that a retiree may wish to utilize while Section V provides conclusions and potential areas for further study.

## II. Previous Studies

Nearly thirty years have passed since the publication of Bengen's watershed article, "Determining Withdrawal Rates Using Historical Data" (1994) proposing the sustainably safe "four percent drawdown rule" as the Financial Planner's "rule of thumb" retirement withdrawal rate. Since then, others have refined, elaborated upon and, often, taken issue with Bengen's original work resulting in the evolution of two groups of retirement withdrawal studies. Research from one perspective has considered portfolio success or failure rates based on constant or inflation-adjusted withdrawals from continuously rebalanced portfolios. The portfolios utilize both stocks and bonds and are considered for specific payment periods or until the portfolios are exhausted. Modifications of withdrawal amounts and rates in the financial plan as well as changes in the portfolios' asset allocations during the payout period are likely. The second perspective examines whether variable or adaptive payouts over actuarial life expectancies and portfolio rebalancing improve the sustainability of withdrawal rates. Several studies suggest procedures for changing the withdrawal rate or amount in response to unanticipated changes in the value of the retirement portfolio.

Bierwirth (1994) used historic returns to compute terminal values of various portfolios of common stock, U.S. Treasury Bonds and U.S. Treasury Bills and concluded that sustainable withdrawal rates ranging from 2.66 percent to 5.19 percent were primarily related to the common stock allocations and showed that stock returns and inflation rates in the early years are extremely important to the success of the retirement portfolio.

Bengen's initial articles (1994, 1996, 1997) examined inflation-adjusted withdrawal rates with allocations to common stocks and longevities up to 50 years based on portfolios of common stocks, U.S. Treasury Bonds and U.S. Treasury Bills. Bengen (1994) recommended a "safe" withdrawal rate of 4% from portfolios of 50 to 75 percent common stock for clients just beginning retirement. Bengen (1996) factored in the client's age in determining the common stock allocation and recommended reducing the common stock allocation by 1 percentage point each year after retirement. Bengen (1997) examined the effects of adding small-company common stocks and U.S. Treasury Bills to retirement portfolios and showed that adding small-company stocks may increase the maximum "safe" withdrawal rate while T-Bills substituted for intermediate term Treasury Bonds will reduce the "safe" withdrawal rate. Bengen (2001) analyzed variable withdrawal plans that supported more spending in the early active peak retirement years, reduced spending in the less active years as health and travel activity decline, and more spending in the final years. He also suggested both a ceiling or floor for the rate of future withdrawals.

Cooley, Hubbard and Waiz (1998, 1999, 2001, 2003, 2005) authored a series of articles that tested the sustainability of fixed annual and inflation-adjusted withdrawals of 3 to 12% using Monte Carlo Simulation for portfolios of large company stocks and high-grade corporate bonds. Their results show that initial withdrawal rates of 5 to 7 percent from portfolios consisting of 50 to 75 percent common stock had success rates of 75 percent or more during the payment periods. Cooley, et. al. (2011) modified the approach based on the record variability of returns in the financial markets and showed that withdrawals must adapt to unexpected losses and require revision in response to unexpected gains and losses.

Pye (2000) calculated portfolio success rates using Monte Carlo simulation for inflation adjusted withdrawals up to 30 years. Key factors for sustainability are the initial withdrawal rate and how future withdrawals are adjusted in response to shortfalls in returns.

Guyton (2004) evaluated the maximum safe initial withdrawal rate during the 40-year period from 1973 to 2003. His analysis used a withdrawal rule that increased the withdrawal rate by the previous year's inflation rate unless the portfolio declined that year and concluded that the maximum "safe" initial withdrawal rate ranges as high as 5.8 percent to 6.2 percent depending on the percentage of the portfolio allocated to equities.

Spitzer, Streiter, and Singh (2007) used a bootstrap simulation to estimate the probability of running out of money in a retirement portfolio when annual withdrawals of a constant real amount are taken. Their results indicate that utilizing withdrawal rates as high as 5.5 to 6 percent indicates a 25 to 30 percent chance of running out of money exists with stock allocations of 75 to 100 percent.

Stout (2008) recommends using Stochastic Optimization to identify optimal portfolio asset allocations for desired withdrawal rates, and then managing withdrawals to reduce or manage the risk of exhausting the retirement portfolio. If the portfolio value rises more than expected, spending could be increased, but only after establishing a reserve fund to help maintain the value of the portfolio for the future. Consistent with other studies, Stout concludes that portfolio sustainability over long retirement horizons requires aggressive portfolios (50 to 75 percent equities). Greater withdrawal rates also require more aggressive portfolio allocations that subject the portfolio to greater market risk and probabilities of failure.

Spitzer, Streiter, and Singh (2008) utilized a bootstrap simulation to investigate the effect of alternative withdrawal strategies on the probability of running out of money over 30 years, assuming a portfolio of stocks and bonds. They examined six constant initial withdrawal rates of 3 percent to 5.5 percent and four adaptive withdrawal models. The adaptive models adjust the annual withdrawal rates in response to annual changes in the value of the retirement portfolio. They concluded if a person is lucky enough to retire when the market is rising, increasing withdrawal amounts are possible. But, several years of declining portfolio values at the beginning of the retirement period requires cutting back on withdrawals.

Blanchett and Frank (2009) recognize that sustainability decisions do not occur just once at retirement but change as situations warrant throughout the retirement years. They evaluate the ongoing sustainability of the withdrawal rate that is revisited every year and changed based on the probability of failure for the remaining target distribution period. Frank and Blanchett (2010) cite sequence risk as a timely issue. Sequence risk is defined as the effect of returns on the probability of success/failure for a distribution portfolio. The authors conclude that this probability is an important value to understand along with the withdrawal rate. Together they provide valuable tools for sequence risk evaluation.

Miller (2010) cited depressed real yields on bonds as the reason current retirees are likely to earn rates of return far below historical returns and shows that if return assumptions are adjusted using current bond yields, the failure rate of an initial 4 percent withdrawal rate increases dramatically. Miller also demonstrated that decreasing the allocation to bonds and increasing the allocation to stocks allows for increases in the safe withdrawal rate of a portfolio at a cost of dramatically changing the risk profile of the portfolio.

The idea of the appropriate rate of withdrawal continues to be of importance and discussion in more recent literature. For example, Gardner and Pittman (2013) discuss the risk of running out of money in retirement and that it is important to consider expected lifespan in determining withdrawal rates from retirement funds. Miller (2016) considers the impact of low bond yields on the success of retirement plans and shows that the probability of failure of retirement plans using a 50-50 balance of equities and bonds in a retirement portfolio dramatically increased. This implies that one must consider heavier weighting in equities (resulting in greater risk exposure) to cover the shortfall.

Bengen (2016) considers the impact of a lower return future investment horizon on a hypothetical year 2000 and year 2008 retiree using a 4.5 percent initial withdrawal rate that had previously been referred to as “safe,” and whether they can have a successful retirement. He concludes that the answer is yes and that the retirees need not make any adjustments in their strategy and their retirement assets should last 30 years.

Blanchett (2017) discusses the concept of guaranteed income and dynamic withdrawals from retirement accounts and finds that guaranteed income levels suggest that a lower withdrawal rate in the initial stages of retirement may be important to the safe sustainability of retirement income. Blanchett and Cormier (2021) consider that some households underspend in retirement resulting in a “retirement consumption gap” due to the underspending in the early years. Reasons for underspending include not being sufficiently well prepared for retirement. Many adjust spending in ways that increase the probability that retirement income will continue throughout the retirement years. Others, who are better prepared may spend less because of the desire to leave bequests and/or provide for uncertain medical expenses.

Marwood and Minnen (2020) build on Bengen’s 4% rule (Bengen 1994) to show that portfolios with greater equity exposure provide the possibility of increased withdrawal rates that are still safe for the retiree. Waggle, Moon, and Lee (2022) study the impact of extremely low bond yields on the viability of traditionally recommended withdrawal rates from retirement portfolios. They show that higher bond allocations lead to shortfalls in retirement funds. Should bond yields return to historical averages, this shortfall might be alleviated, however, retirees must know that holding bonds in an increasing yield environment will result in capital losses in the bond portion of their portfolio.

This study adds to our understanding of acceptable withdrawal rates by utilizing historic equity and debt returns to compute and simulate the impact of computed withdrawal rates on the longevity of defined contribution retirement portfolios. It considers varying combinations of equity and debt in determining possible rates of withdrawal.

### **III. METHODOLOGY**

This section presents a straightforward method for estimating the income level that one might expect at retirement, the portfolio value and composition necessary to attain that income

level, and a methodology that may be utilized to estimate the sustainable rate of withdrawal from that portfolio over a retirement period (life span) of up to 40 years.

A number of analytical approaches are available for predicting one's inflation adjusted annual income over an assumed retirement period (see Bengen (1994) and Cooley, et. al. (1998)). Retirement planners use this information to estimate the value of a portfolio that will "statistically" produce this annual income for a given number of years. The final step is to recommend a **saving profile** that will achieve this goal based on current information and our best guess of what the future holds. But there are many challenges! In general, the planner is faced with an uncertain future that may change significantly before retirement: job changes, unemployment, promotion, illnesses, "bucket list" changes, unplanned obligations, unexpected monetary gains and losses, taxes and regulation changes to name a few examples. Financial plans should be periodically reviewed and receive special attention when significant changes occur. A good rule is to review financial plans at least every two years. It is important to make adjustments early to minimize the magnitude of the adjustments. In this sense, retirement planning is an iterative process that seeks to identify a trajectory that leads to a successful retirement.

This paper proposes an adaptive process that uses historical data arrays to predict future values based upon identified retirement needs. The three data arrays utilized are 1.) Future Value Factors (FVFs) for Inflation, 2.) FVFs for Income, and Future Value Annuity Factors (FVAF) for estimating saving requirements.

Individuals should mathematically estimate funding needed if retirement occurs today using accepted financial models. One can then project that financial requirement to the actual retirement date using FVFs for inflation. Once this projection is completed an expanded "four-percent rule" is one method for staying on a successful retirement trajectory and it is the subject of this paper.

The **Solution Matrix Generator Program** uses **equation 1** (presented below) and 16 to 40 years of contiguous historical monthly data to compute **Lambda**. Lambda is the percent of the initial portfolio's value one can withdraw the first year (paid monthly) with a high probability of generating inflation adjusted monthly income for the assumed 16 to 40 years in retirement. The program uses historical financial data and stochastic modeling to build a histogram of **Lambdas**.

As shown in Table 1, this process uses three fixed arrays: The array at the top of the solution matrix is the assumed number of **years in retirement**, the array down the left side of the solution matrix is the **percent of stocks and bonds** in the portfolio, and the array at the top of Panel A is the number of **years to retirement that is used in the adaptive process**. For a given "Confidence Interval", Lambdas for all combinations of years in retirement and stock/bond allocations are represented in the solution matrix.

The derivation of the equation for computing Lambdas assumes the following: withdrawals are at the end of the period (Month), portfolio income is tax-deferred or tax-free, and the portfolio gain is not adjusted for transaction cost.

**Table 1**  
**Simulation Results: 90% Confidence Interval**

% Stock	YEARS IN RETIREMENT												
	16	18	20	22	24	26	28	30	32	34	36	38	40
0.00	5.20	4.50	4.06	3.71	3.43	3.18	2.96	2.78	2.62	2.47	2.31	2.20	2.09
0.07	5.56	4.91	4.47	4.15	3.82	3.56	3.33	3.14	2.97	2.81	2.63	2.52	2.39
0.14	5.99	5.37	4.89	4.52	4.20	3.89	3.68	3.47	3.27	3.12	2.96	2.83	2.71
0.21	6.08	5.50	5.07	4.74	4.45	4.23	4.01	3.83	3.68	3.44	3.29	3.16	3.05
0.29	6.16	5.63	5.23	4.83	4.62	4.41	4.25	4.03	3.91	3.78	3.66	3.52	3.41
0.36	6.26	5.73	5.32	5.00	4.80	4.55	4.38	4.26	4.11	4.02	3.90	3.79	3.67
0.43	6.37	5.76	5.40	5.11	4.96	4.69	4.51	4.35	4.26	4.17	4.07	3.98	3.87
0.50	6.32	5.87	5.40	5.14	4.94	4.73	4.59	4.43	4.31	4.23	4.17	4.06	4.00
0.57	6.26	5.84	5.37	5.20	4.96	4.81	4.67	4.50	4.37	4.30	4.24	4.18	4.04
0.64	6.38	5.84	5.48	5.17	4.95	4.82	4.67	4.45	4.46	4.34	4.33	4.21	4.10
0.71	6.36	5.81	5.40	5.18	4.94	4.78	4.73	4.65	4.56	4.38	4.33	4.23	4.15
0.79	6.23	5.69	5.42	5.06	4.82	4.76	4.63	4.50	4.40	4.34	4.32	4.19	4.11
0.86	6.10	5.62	5.44	5.03	4.82	4.60	4.51	4.50	4.30	4.28	4.23	4.13	4.12
0.93	6.00	5.51	5.23	4.99	4.75	4.69	4.63	4.41	4.26	4.25	4.25	4.09	4.08
1.00	5.90	5.46	5.13	4.86	4.72	4.51	4.43	4.35	4.30	4.21	4.12	4.05	4.02

## ALGORITHMS

### 1. COMPUTING LAMBDA

Let

$M$  = Assumed number of months in retirement

$j_m$  = Monthly inflation rate

$i_m$  = Monthly total return

The Present Value Annuity Factor for monthly data can be written as:

$$PVAF = \left( \frac{1}{1 + i_0} \right) \sum_{m=0}^{M-1} \frac{N_m}{D_m}$$

Where

$$N_0 = D_0 = 1$$

When  $m > 0$ ,

$$N_m = N_{m-1}(1 + j_m)$$

$$D_m = D_{m-1}(1 + i_m)$$

Lambda ( $\lambda$ ) is the percent of an initial portfolio ( $P_0$ ) one can withdraw the first year. And one can withdraw ( $\lambda P_0 / 12$ ) at the end of the first month and adjust this amount for inflation during subsequent monthly withdrawals with a high probability of ending with a positive portfolio.

Assuming income withdrawals are monthly, we have:

$$P_0 = \left( \frac{\lambda P_0}{12} \right) \left( \frac{1}{1+i_0} \right) \sum_{m=0}^{M-1} \frac{N_m}{D_m}$$

And the final equation for computing yearly Lambda is:

$$\lambda = \frac{12}{\left( \frac{1}{1+i_0} \right) \sum_{m=0}^{M-1} \frac{N_m}{D_m}} \tag{Eq. 1}$$

## 2. COMPUTING THRESHOLD

Let

- $\lambda_k$  = The Lambda associated with cell k
- $C_k$  = The sum of all observations placed in cell k
- $N_t$  = Total number of observations in the histogram (**4000**)
- $N_s$  = The number of cells added before the left side of Eq. 5 is equal the right side.
- $p(x_k)$  = The probability associated with  $Cell_k$  is equal to  $C_k/N_t$
- $\delta$  = Confidence level (**0.90, 0.95, or 0.99**) [Alpha,  $\alpha = (1 - \delta)$ ]

The probability that  $X > k$  is given by:

$$P(X > k) = 1 - P(X \leq k) \tag{Eq. 2}$$

In Discrete terms

$$P(X > k) = \left\{ 1 - \underbrace{[p(x_1) + p(x_2) + \dots + p(x_k)]}_{P(X \leq k)} \right\} \tag{Eq. 3}$$

Where

$$P(X \leq k) = [p(x_1) + p(x_2) + \dots + p(x_k)] = (1 - \delta)$$

Expressed in counts after the last cell is summed, the threshold is:

$$N_t [p(x_1) + p(x_2) + \dots + p(x_k)] = (1 - \delta) N_t \tag{Eq. 4}$$

Equation 3 can be written as

$$\sum_1^{N_s} \frac{C_k}{N_t} = \left( \frac{1}{N_t} \sum_1^{N_s} C_k \right) = (1 - \delta)$$

or

$$\sum_1^{N_s} C_k = (1 - \delta) N_t \quad \text{Where } k = 1, 2, \dots, N_s \tag{Eq. 5}$$

Continue summing until left side of Eq. 5 is equal to (or greater than) the right side. Assume this occurs when  $k = N_s$ . The left side may be slightly greater due to histogram quantization (< 0.01 percent).

$$\sum_1^{N_s} C_k = (1 - \delta)N_t$$

**Note:** The right side of the equation is the **expected value of the sum of observations from 1 to  $N_s$**  and is referred to as **the Threshold**. The **Solution Matrix Value** is:

$$\lambda_k = 0.01(N_s)$$

The expression  $(1 - \delta)$  has the following values:

- =0.01 when Confidence interval is 99% (0.99)
- =0.05 when Confidence interval is 95% (0.95)
- =0.10 when Confidence interval is 90% (0.90)

### 3. COMPUTING MARGIN OF ERROR

1. The margin of error (ME) is expressed as:

$$ME = z \sqrt{\frac{\hat{p}(1 - \hat{p})}{N_t}} \tag{Eq. 6}$$

Where,

$\hat{p}$  = An estimate of the sample proportions: It is the percent of the sample population required to compute a solution matrix entry.

$N_t$  = The sample size.

$z$  = Z-values (critical values) for selected confidence intervals.

$\delta$  = Confidence Levels: 90%, 95%, and 99%

2. The following constraints must be observed.

$$(N_t)\hat{p} \geq 10, N_t(1 - \hat{p}) \geq 10, \text{ and } N_t(1 - \delta) \geq 10$$

Estimates of  $\hat{p}$  for the various confidence intervals are:

Sample	Confidence	$z^* - val$	$\hat{p}$	$(1 - \hat{p})$	ME
4000	90%	1.645	0.1	0.90	0.0078
4000	95%	1.96	0.05	0.95	0.0067
4000	99%	2.58	0.01	0.99	0.0040

Note: All Margin of Errors are less than one percent.

## IV. SIMULATION RESULTS

Table 1 shows the results of the above simulation for a number of retirement periods and estimates of the different parameters utilized in the simulation for the 90% confidence interval. The “sample size” indicates that the results are presented for 4000 simulations utilizing data randomly selected from 1926 through 2018 for both stock and bonds to simulate portfolio returns. “Years in Retirement” show that the rate of withdrawal that one can take from their retirement account and be 90% confident that retirement savings accumulated during ones working years are sufficient to provide the level of income in retirement that one desires. The

rate of savings necessary will depend upon the desired income level in retirement and should be established utilizing the financial information and resources available to the prospective retiree.

Concentrating on Table 1, one can see the various withdrawal rates available for retirees based upon varying combinations of stocks and bonds and for different numbers of years of expected retirement. For example, if one expects to live in retirement for 30 years and invests in a portfolio that consists of 57% stocks and 43% bonds, an annual withdrawal rate of 4.5% from the portfolio will leave the retiree with a positive portfolio balanced with 90% confidence.<sup>6</sup> It is evident from the simulation that for one to achieve their desired income levels in retirement for significant time periods, the portfolio must include both stocks and bonds as the maximum withdrawal levels flow from portfolios with approximately 57% to 65% stocks for all expected “years in retirement”.

Table 2 provides the same information as Table 1 except that retirees can be 95% confident that funds will last the specified number of years, while Table 3 provides the information for 99% confidence. From the 30 years in retirement column we see that the withdrawal rates must be reduced slightly to have the increased level of confidence with the rate approaching 4%, the commonly used rule of thumb for withdrawal from retirement accounts.

**Table 2**  
**Simulation Results: 95% Confidence Interval**

% Stock	YEARS TO RETIREMENT												
	16	18	20	22	24	26	28	30	32	34	36	38	40
0.00	4.93	4.36	3.90	3.48	3.29	3.02	2.85	2.67	2.49	2.29	2.18	2.02	1.92
0.07	5.27	4.76	4.32	3.91	3.66	3.36	3.24	2.90	2.77	2.66	2.55	2.39	2.23
0.14	5.70	5.15	4.70	4.30	3.98	3.63	3.50	3.26	3.12	2.93	2.79	2.69	2.55
0.21	5.96	5.40	4.93	4.59	4.29	4.02	3.83	3.64	3.46	3.36	3.17	3.05	2.91
0.29	6.06	5.49	5.06	4.75	4.51	4.30	4.11	3.98	3.78	3.66	3.50	3.38	3.26
0.36	6.10	5.54	5.17	4.90	4.65	4.47	4.28	4.14	4.01	3.90	3.81	3.71	3.58
0.43	6.11	5.58	5.17	4.88	4.69	4.48	4.34	4.23	4.12	4.04	3.92	3.87	3.80
0.50	6.07	5.61	5.18	4.91	4.67	4.51	4.35	4.25	4.17	4.10	4.03	3.95	3.88
0.57	6.09	5.48	5.16	4.93	4.66	4.51	4.38	4.27	4.20	4.07	4.05	3.97	3.92
0.64	6.00	5.56	5.15	4.88	4.64	4.52	4.34	4.29	4.16	4.11	4.05	4.01	3.95
0.71	5.99	5.44	5.12	4.86	4.61	4.47	4.38	4.23	4.17	4.12	4.08	4.00	3.96
0.79	5.89	5.42	5.08	4.82	4.63	4.45	4.32	4.24	4.24	4.10	4.05	3.99	3.95
0.86	5.82	5.35	5.05	4.71	4.56	4.40	4.28	4.20	4.16	4.09	4.04	4.00	3.91
0.93	5.74	5.27	4.89	4.63	4.46	4.30	4.21	4.10	4.10	4.00	3.97	3.91	3.87
1.00	5.59	5.07	4.79	4.53	4.44	4.23	4.18	4.04	4.01	3.97	3.92	3.86	3.84

<sup>6</sup> Data utilized for this study was taken randomly from the Ibbotson *SBBI Yearbook*.

**Table 3**  
**Simulation Results: 99% Confidence Interval**

% Stock	Years in Retirement												
	16	18	20	22	24	26	28	30	32	34	36	38	40
0.00	4.63	4.07	3.58	3.28	3.01	2.79	2.59	2.43	2.29	2.16	2.05	1.94	1.83
0.07	4.95	4.39	3.95	3.62	3.34	3.13	2.94	2.77	2.61	2.47	2.36	2.25	2.13
0.14	5.26	4.71	4.29	3.98	3.70	3.48	3.28	3.11	2.95	2.82	2.67	2.57	2.44
0.21	5.59	5.08	4.65	4.30	4.06	3.85	3.64	3.47	3.32	3.18	3.04	2.91	2.80
0.29	5.89	5.37	4.98	4.66	4.40	4.18	3.99	3.83	3.67	3.53	3.38	3.27	3.14
0.36	5.96	5.43	5.01	4.74	4.51	4.30	4.15	4.02	3.92	3.79	3.68	3.57	3.43
0.43	5.93	5.41	5.02	4.72	4.51	4.32	4.21	4.06	3.97	3.88	3.84	3.76	3.68
0.50	5.83	5.37	5.00	4.73	4.51	4.34	4.20	4.11	4.03	3.91	3.86	3.83	3.76
0.57	5.80	5.36	4.96	4.73	4.53	4.34	4.21	4.10	3.99	3.94	3.89	3.83	3.78
0.64	5.74	5.28	4.95	4.70	4.49	4.35	4.19	4.11	4.02	3.96	3.90	3.84	3.78
0.71	5.64	5.21	4.89	4.68	4.45	4.32	4.19	4.09	4.01	3.95	3.91	3.86	3.84
0.79	5.58	5.15	4.85	4.58	4.40	4.26	4.19	4.09	4.04	3.98	3.89	3.84	3.83
0.86	5.44	5.08	4.79	4.55	4.40	4.23	4.11	4.02	3.96	3.92	3.86	3.85	3.79
0.93	5.27	4.87	4.54	4.35	4.19	4.12	4.00	3.94	3.86	3.87	3.79	3.79	3.77
1.00	4.85	4.51	4.23	4.00	3.86	3.80	3.70	3.65	3.68	3.58	3.55	3.53	3.51

Table 4 shows three auxiliary **Panels A, B, and C** that can be used to aid the financial planner in adjusting savings and/or spending requirements for the 90% confidence interval. The array at the top of Panel A is the number of **years to retirement** and it is used to select the appropriate values from Panels A, B, and C when adjustments are required. (The percent of stock to the left of Panel A is used to identify the source of the data but **is not used** in the computation.<sup>7</sup>) Tables 5 and 6 provide the same information for the 95% and 99% confidence interval, respectively.

**Table 4**  
**Adjustment Factors 90% Confidence Interval**

% Stock	YEARS IN RETIREMENT												
	16	18	20	22	24	26	28	30	32	34	36	38	40
0.43	1.30	1.41	1.51	1.68	1.74	1.95	2.10	1.97	2.12	2.38	2.12	2.24	2.70
0.50	1.31	1.41	1.52	1.66	1.77	1.98	1.80	2.04	1.97	1.94	2.14	2.24	2.55
0.57	1.30	1.42	1.52	1.66	1.75	1.97	1.94	2.24	2.12	1.94	2.23	2.14	2.39
0.64	1.31	1.42	1.53	1.63	1.77	1.99	2.13	2.26	2.04	2.11	1.98	2.24	2.37
0.71	1.30	1.40	1.48	1.65	1.75	1.96	1.97	1.99	1.97	2.18	2.20	2.12	2.28
W	PANEL B: FVF for INCOME												
0.43	2.35	2.74	3.21	3.70	4.19	4.94	5.90	6.64	7.49	8.64	9.50	10.84	12.03
0.50	2.45	2.80	3.35	3.88	4.63	5.63	6.65	7.97	8.83	10.14	11.39	13.09	14.61
0.57	2.50	2.86	3.45	4.07	4.81	6.14	7.49	9.11	10.62	11.81	13.51	15.66	16.85
0.64	2.47	2.92	3.52	4.13	5.26	6.70	8.45	10.41	12.21	13.97	15.67	18.40	20.24
0.71	2.44	2.94	3.54	4.34	5.31	7.11	9.02	11.49	13.91	16.51	18.29	20.99	23.52
	PANEL C: FVAF for INCOME												
0.43	24.83	30.58	36.67	44.17	51.17	60.83	71.50	83.25	98.25	115.42	131.50	152.25	177.50
0.50	25.08	30.67	37.92	45.58	54.75	65.50	74.92	92.92	106.75	125.25	148.42	173.50	201.92
0.57	25.17	31.00	38.33	47.08	56.42	67.58	80.83	101.58	123.83	139.33	169.50	194.50	227.67
0.64	25.08	31.08	38.83	47.33	58.33	71.25	87.42	110.25	132.08	158.00	183.42	221.50	258.25
0.71	24.92	31.42	38.83	48.50	59.00	72.50	88.42	109.25	137.00	177.58	211.50	242.25	288.33

<sup>7</sup> An example of utilizing the adaptive process is available from the authors upon request.

**Table 5**  
**Adjustment Factors 95% Confidence Interval**

YEARS TO RETIREMENT		PANEL A: FVF for INFLATION											
% Stock	16	18	20	22	24	26	28	30	32	34	36	38	40
0.43	1.06	1.29	1.40	1.52	1.55	1.57	1.64	1.69	1.73	1.77	1.81	1.90	1.96
0.50	1.06	1.29	1.40	1.51	1.56	1.57	1.61	1.69	1.72	1.76	1.82	1.92	2.08
0.57	1.05	1.29	1.39	1.50	1.56	1.56	1.60	1.69	1.74	1.78	1.81	1.90	2.04
0.64	1.04	1.35	1.39	1.44	1.56	1.57	1.60	1.69	1.73	1.77	1.81	1.90	2.01
0.71	1.05	1.29	1.39	1.51	1.56	1.57	1.61	1.69	1.73	1.77	1.81	1.88	1.97
		PANEL B: FVF for INCOME											
0.43	2.19	2.59	2.95	3.24	3.86	4.62	5.55	5.99	6.96	7.81	9.12	9.43	11.47
0.50	2.22	2.68	2.94	3.32	4.10	5.06	6.32	7.15	8.27	8.74	10.46	10.94	13.52
0.57	2.18	2.71	3.06	3.42	4.46	5.38	7.11	7.86	9.34	10.55	12.42	13.03	15.91
0.64	2.13	2.75	2.81	3.48	4.69	5.76	7.88	9.03	10.94	12.67	14.24	15.94	18.38
0.71	2.16	2.72	3.01	3.65	4.80	6.12	8.60	9.61	12.16	14.41	16.69	18.25	21.31
		PANEL C: FVAF for INCOME											
0.43	23.00	27.83	33.42	40.08	47.17	54.67	63.42	75.42	86.83	105.17	119.58	139.58	163.08
0.50	23.42	28.83	33.33	39.00	46.08	56.83	66.58	86.33	95.50	108.83	132.92	150.50	184.17
0.57	23.08	27.92	33.58	38.75	50.17	57.58	72.83	84.75	99.67	121.25	141.00	166.33	203.00
0.64	22.58	28.92	32.33	38.33	50.33	63.17	70.42	89.92	110.50	129.83	153.58	190.08	216.17
0.71	22.83	26.75	33.00	38.83	47.50	57.58	71.92	90.33	113.17	140.50	169.00	208.08	243.33

**Table 6**  
**Adjustment Factors 99% Confidence Interval**

		Years in Retirement											
% Stock	16.00	18.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00
		PANEL A: FVF FOR INFLATION											
0.43	0.95	1.01	1.13	1.36	1.40	1.52	1.52	1.52	1.65	1.69	1.73	1.75	1.86
0.50	0.94	1.00	1.17	1.36	1.39	1.51	1.52	1.56	1.64	1.69	1.72	1.74	1.86
0.57	0.91	1.01	1.16	1.36	1.40	1.51	1.52	1.56	1.64	1.69	1.72	1.74	1.86
0.64	0.95	0.99	1.18	1.36	1.35	1.52	1.52	1.57	1.64	1.66	1.72	1.77	1.81
0.71	0.94	0.99	1.16	1.36	1.39	1.51	1.52	1.56	1.64	1.69	1.72	1.75	1.83
		PANEL B: FVF FOR INCOME											
0.43	2.01	2.10	2.30	2.89	3.37	4.19	4.78	5.51	6.37	7.17	8.45	8.92	9.47
0.50	1.97	2.13	2.49	3.05	3.54	4.57	5.21	6.31	7.27	8.19	9.69	9.87	10.89
0.57	1.93	2.05	2.26	3.06	3.67	4.90	5.82	6.90	8.14	9.09	11.22	11.85	13.07
0.64	1.87	2.04	2.28	3.09	3.91	5.21	6.30	7.77	8.86	10.15	12.66	13.41	14.75
0.71	1.82	1.98	2.15	3.20	3.94	5.51	6.75	8.52	9.60	11.27	14.50	15.08	16.68
		PANEL C: FVAF for INCOME											
0.43	20.42	24.33	28.75	33.92	40.42	47.58	57.00	65.67	79.58	92.83	108.75	126.25	145.50
0.50	19.42	23.67	28.42	33.17	39.92	47.75	57.75	69.67	83.17	98.92	116.25	136.58	159.75
0.57	18.50	22.42	26.92	32.08	38.83	47.58	58.75	72.83	87.00	103.08	124.75	148.25	174.00
0.64	17.58	21.75	25.92	30.83	38.50	47.00	59.33	73.00	89.25	107.92	131.25	161.00	188.33
0.71	16.83	20.67	24.58	30.42	37.50	46.33	58.92	74.08	91.25	113.17	138.58	168.25	202.75

**V. CONCLUSION**

One cannot develop a static retirement plan at age 25 and feel secure about accumulating the resources required to retire successfully. Appropriate use of time is critical for a successful outcome. Consider the following:

1. **Starting too late:** Charles Schwab estimates you will need to save 10 – 15% of your pre-tax income if you start saving for retirement in your 20s. And you will need 15 – 25% if you begin in your 30s.

2. **Taking your eyes off the ball:** Planning for and during retirement requires periodically reviewing retirement needs and current position to achieve your goals. It is imperative that timely adjustments be made to maintain your retirement trajectory. This paper provides a roadmap to assist investors and their retirement planners to realize their financial objectives throughout their retirement years.

Through all of this, the rate of withdrawal available to retirees with confidence that they can maintain a positive portfolio balance will vary with the expected years in retirement. While none of us know just how long our retirement time will be, these simulations provide some direction for withdrawal rates that retirees can draw upon based on their individual family history.

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## APPENDIX 1

This paper uses the following process to adjust for inflation:

1. During saving for retirement each payment is increased by the historical level of inflation before discounting the inflation adjusted amount back to time 0 for each period.
2. The historically derived return to discount each amount.
3. The sum then provides the present value of all future inflation adjusted income and the present value of the portfolio to provide the future inflation adjusted income for the period of interest.