Contribution

National Savings Rate Guidelines for Individuals

by Roger Ibbotson, Ph.D.; James Xiong, Ph.D., CFA; Robert P. Kreitler, CFP®; Charles F. Kreitler; and Peng Chen, Ph.D., CFA

Executive Summary

- This study creates savings guidelines for typical individuals with different ages, income levels, and initial accumulated wealth so the public can more easily determine how much to save for retirement. It also creates benchmarks for how much capital an individual would have accumulated based on their income and age, with the presumption that they started saving at age 35. Additionally, it shows targets for how much an individual should have accumulated at age 65, prior to retiring. The authors recommend that their findings be adopted as national savings guidelines.
- The study differs from previous savings studies in several important ways. Perhaps most key is that the savings guidelines and capital needs are calculated on retirement income as a percent of *net* pre-retirement income—gross income minus annual retirement savings in pre-retirement. The study also uses Monte Carlo simulations and Ibbotson Associates' forecasted returns to calculate capital required for retirement.
- The article calculates retirement cash flow using an 80 percent replacement ratio of pre-tax pre-retirement net income for a single person, along with other assumptions. As a comparison, it shows the difference in savings required for 60 and 80 percent replacement ratios without the pre-retirement net income approach. The study takes into account Social Security benefits, and shows that higher-income individuals need to save at substantially higher rates in order to offset the impact of Social Security benefits being skewed to lower-income individuals.
- The study shows the urgency of starting to save no later than age 35. It also suggests that those whose income increases faster than inflation will have to save an increasing amount to "catch up" so as to be able to provide for the higher assumed standard of living in retirement.

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In recent years there has been a significant shift in retirement practices in the United States from reliance on defined-benefit pension plans to self-directed defined-contribution plans such as 401(k) plans. Retirees increasingly must rely on cash flow from their own resources (including defined-contribution and IRA plans) to help pay for their retirement.

To achieve this, future retirees must acquire sufficient wealth to generate this cash flow. "Accumulation" is a function of both savings and investment performance. The market is variable and retirees cannot control their investment returns. Therefore, this paper focuses on savings, which is within their control.

Few workers appear to have the discipline to save adequately (Helman and Paladino 2004, Thaler and Bernatzi 2004). According to the 14th Retirement Confidence Survey in 2004, many American workers have saved some money for retirement, but many of them cite low levels of savings and investments, and 40 percent of workers say they are not *currently* saving for retirement (Helman and Paladino 2004). A large proportion of employees at firms that offer only defined-contribution plans contribute nothing, or little, or do not fund their 401(k) plans sufficiently to receive the full match that their employers provide.

There are a large number of variables involved in every unique retirement planning situation. This study does not attempt to address every variable, but provides general guidelines for individuals and planners. The study incorporates commonly accepted figures to simplify wherever possible. The study demonstrates that achieving sufficient retirement income is possible with reasonable savings rates. Not surprisingly, there is a premium on starting early. Those who do save early can save without a significant drop in lifestyle. A critical inflection point occurs at age 35 to 40. Those individuals starting their retirement savings after that age face the challenge of an increasingly higher savings rate needed to accumulate sufficient capital.

Other studies have developed savings guidelines. Thomas Walsh in 2003 used a deterministic method in which a single number (8 percent) was assumed for investment returns to estimate how much a person should save for retirement. In our study, we use a similar approach but improve on the methodology in two ways:

1. To calculate the savings rates, we calculate income needed in retirement based on retirement income as a percent of *net* pre-retirement income, which we define as gross income less the amount saved for retirement each year during pre-retirement. Basing retirement costs on pre-retirement net income rather than gross income, as done with other studies, significantly reduces the amount that must be saved.
2. For estimating the savings rate needed to build the capital to sustain retirement, we used Monte Carlo simulations and Ibbotson Associates' forecasted long-term capital market returns.

Like Walsh, we developed a general savings rate guideline for individuals with different ages, income levels, and initial capital saved.

The analysis was performed in three steps, explained in more detail below. We calculated

1. The annual cash flow needed in retirement

2. The capital needed to generate this lifetime retirement cash flow
3. The annual savings needed to build the capital that will provide the retirement cash flow

This improved methodology, along with the three-step analysis, results in savings guidelines that individuals of different ages, incomes, and accumulated wealth can easily apply in determining how much to save for an adequate retirement. Second, by taking into account the impact of Social Security benefits, the study reveals the need for higher-income workers to save at substantially higher rates. Third, the study illustrates the need for workers to periodically return to these guidelines in order to determine if their savings rates are sufficient to maintain a desired standard of living for retirement. Finally, the study reinforces the importance of starting to save early. The recommended savings rate for a person starting to save at age 25 typically more than doubles if they wait until age 45 to start saving, and triples if they wait until age 55 to start.

Retirement Cash Flow

We calculated retirement cash flow in three ways. First, we assumed retirement would be at age 65 and that retirement cash flow would be equal to 80 percent (replacement ratio) of pre-tax pre-retirement gross income at age 64. The age 65 retirement date is based on the popular use of that age in planning. The 80 percent is based on the AON Consulting/Georgia State University 2004 Retirement Income Replacement Ratio Study. (The study reported very low savings rates in estimating the 80 percent replacement ratio.) Individuals desiring different replacement ratios will need to adjust their savings up or down to meet their objectives. It should be noted that nothing has been included in these numbers for late-in-life medical costs.

We assumed post-retirement cash-flow needs would increase with inflation (2.5 percent as assumed by Ibbotson Associates, December 2005). To determine pre-retirement income we assumed individual income would grow at the rate of inflation (2.5 percent) from current age to retirement age.

In our second scenario, we repeated the above analysis using a 60 percent replacement ratio. There are many individuals who will not need the full 80 percent replacement of income in retirement, either because they plan to reduce their standard of living more in retirement or they have expenses that will disappear or reduce dramatically in retirement (for example, mortgage paid off, college expenses completed, and savings programs funded).

Third, we used a more sophisticated approach by using the retirement ratio of 80 percent based on *pre-retirement net income as defined as gross income less retirement savings*. We used net income because someone who saves for retirement has reduced their pre-retirement living expenses and, for most, it typically follows that they also reduce their post-retirement expenses. For individuals who are saving a lot, this can be significant. Lower retirement expenses means less needed capital. You could say the more one saves, the less one needs to save. The mathematics for calculating this can be relatively complicated. Appendix A explains how these calculations were done.

Using net income is a realistic approach for both retirees and planners. Workers can make small adjustments to current lifestyle (spending) in order to continue that adjusted lifestyle (income) in retirement, thus avoiding radical changes in their lifestyle. Using gross income as the retirement income target forces an individual to save more and to make a more radical reduction in current lifestyle, resulting in excess capital that can generate an increase in lifestyle upon retirement. In short, the amount saved could theoretically be too much and provide a higher standard of living in retirement than while working.
Table 1 shows the savings rates for the first two scenarios. Table 2 (p. 54) shows the third scenario. The national savings guidelines that we suggest adopting are based on Table 2 and base the replacement ratio on net income. These two tables will be discussed later under "Results."

Table 1: Savings Rate for Different Income Levels with 80% or 60% Replacement of Gross Income and No Past Savings

Age	Income	Savings Rate for 80% Income Replacement	Savings Rate for 60% Income Replacement
25	$20,000	6.8%	1.4%
25	$40,000	10.0%	4.6%
25	$60,000	12.0%	6.4%
25	$80,000	13.8%	8.0%
30	$20,000	8.8%	2.0%
30	$40,000	12.8%	5.8%
30	$60,000	15.6%	8.4%
30	$80,000	17.2%	10.4%
35	$20,000	11.4%	2.4%
35	$40,000	16.4%	7.4%
35	$60,000	19.6%	10.6%
35	$80,000	22.0%	13.2%
35	$100,000	23.8%	14.8%
40	$20,000	14.8%	3.2%
40	$40,000	21.6%	9.8%
40	$60,000	25.8%	14.2%
40	$80,000	29.0%	17.4%
40	$100,000	31.0%	19.8%
45	$20,000	20.0%	4.2%
45	$40,000	29.4%	13.4%
45	$60,000	35.0%	19.4%
45	$80,000	39.4%	23.6%
45	$100,000	42.8%	26.8%
45	$120,000	46.2%	30.2%
50	$20,000	28.8%	6.0%
50	$40,000	42.4%	19.0%
50	$60,000	50.0%	27.2%
50	$80,000	56.8%	33.4%
50	$100,000	61.0%	39.0%
50	$120,000	66.6%	43.8%
55	$20,000	45.6%	9.6%
55	$40,000	66.6%	30.2%
55	$60,000	79.8%	43.8%
55	$80,000	89.6%	53.2%
55	$100,000	97.0%	62.0%
55	$120,000	105.6%	70.0%
60	$20,000	94.6%	19.6%
60	$40,000	137.2%	62.4%
60	$60,000	>150%	89.8%
60	$80,000	>150%	111.2%
60	$100,000	>150%	130.2%
60	$120,000	>150%	146.0%

Table 2: Savings Rate for Different Gross Income Levels with 80% Replacement of Net Income

Age	Income	Savings Rate	Deduction Each $10,000 of Portfolio
25	$20,000	5.8%	1.60%
25	$40,000	8.2%	0.78%
25	$60,000	10.0%	0.55%
25	$80,000	11.2%	0.40%
30	$20,000	7.0%	1.65%
30	$40,000	10.0%	0.79%
30	$60,000	11.8%	0.54%
30	$80,000	13.6%	0.42%
35	$20,000	8.6%	1.75%
35	$40,000	12.2%	0.86%
35	$60,000	14.6%	0.55%
35	$80,000	16.4%	0.43%
35	$100,000	17.6%	0.34%
40	$20,000	10.2%	1.67%
40	$40,000	14.8%	0.86%
40	$60,000	17.6%	0.57%
40	$80,000	19.8%	0.42%
40	$100,000	21.4%	0.35%
45	$20,000	12.4%	1.76%
45	$40,000	18.0%	0.90%
45	$60,000	21.4%	0.59%
45	$80,000	24.0%	0.45%
45	$100,000	26.2%	0.37%
45	$120,000	28.2%	0.31%
50	$20,000	15.0%	1.87%
50	$40,000	22.0%	0.97%
50	$60,000	26.2%	0.64%
50	$80,000	29.8%	0.48%
50	$100,000	32.2%	0.39%
50	$120,000	35.0%	0.33%
55	$20,000	18.6%	2.11%
55	$40,000	27.2%	1.04%
55	$60,000	32.6%	0.71%
55	$80,000	36.6%	0.53%
55	$100,000	40.2%	0.43%
55	$120,000	43.6%	0.36%
60	$20,000	23.8%	2.39%
60	$40,000	34.4%	1.23%
60	$60,000	41.2%	0.81%
60	$80,000	46.8%	0.61%
60	$100,000	51.4%	0.50%
60	$120,000	55.4%	0.41%

Capital Needed to Generate Retirement Cash Flow

We assumed retirement cash flow would come from both Social Security and distributions from personal capital.

The Social Security benefits are based, with some simplifications, on program code that the Social Security Administration posts on its Web site (http://www.socialsecurity.gov/OACT/ANYPIA/anypia.html). One of the simplifications was to assume full Social Security benefits were available at age 65 instead of age 67 to match the commonly accepted retirement age. But individuals should strongly consider delaying taking Social Security until they receive the full benefit. At each income level, the corresponding Social Security benefits are assumed to increase at the same rate of inflation as the income level.

To estimate the capital needed to provide the cash flow not covered by Social Security, we assumed the capital would be invested in inflation-indexed lifetime fixed-payout annuities and calculated how much to buy to provide the desired cash flow. These create inflation-adjusted lifetime income, regardless of how long the retiree lives. The amount purchased is that which will provide the needed annual retirement cash flow from step 1. We used the industry averages for the fees and expenses, estimated as 0.8 percent. The total required amount for retirement is calculated as the discounted value of expected annuities for the entire retired life weighted by surviving probabilities with a discount rate of 4 percent. Annual annuity payment is set to provide the retirement goal, 80 percent of final salary net of savings.

Retirement income is needed for one's life, and the length of a person's life is subject to uncertainty. Therefore, we used a probabilistic mortality rate model to address the uncertainty. The savings rate guideline in this study is for an individual person, and we calculate this individual's mortality rate as the average of male and female mortality rates. Mortality rates are from the Society of Actuaries' 2000 mortality rate table. From this table, for example, an individual at age 64 will have a 0.81 percent probability of dying in the next year.

The capital needed to fund retirement at age 65 at various income levels is shown in Table 3 (p. 54). For example, if a person is at age 65 and just retired with a final salary of $100,000, his or her expected inflation-adjusted annual retirement income is $65,920 to provide the same lifestyle as their pre-retirement. Estimated Social Security benefits are $27,343 and the balance of $38,577 is distributed from savings. The last row in Table 3 is also the amount needed to buy the inflation-indexed lifetime fixed-payout annuities mentioned earlier.

Table 3: Calculation of Assets Needed at Age 65 to Provide Retirement Cash Flow

Income Pre-retirement	$20,000	$40,000	$60,000	$80,000	$100,000	$120,000
Less Annual Contributions to Savings	$1,720	$4,880	$8,760	$13,120	$17,600	$23,040
Net Income (Gross Less Savings)	$18,280	$35,120	$51,240	$66,880	$82,400	$96,960
Income Post-Retirement (80% Replacement of Net Income)	$14,624	$28,096	$40,992	$53,504	$65,920	$77,568
Sources of Retirement Income						
Estimated Social Security	$11,242	$17,798	$22,177	$25,252	$27,343	$27,343
Pension or Other Income	—	—	—	—	—	—
Annual Cash Flow from Portfolio	$3,382	$10,298	$18,815	$28,252	$38,577	$50,225
Total Annual Income in Retirement	$14,624	$28,096	$40,992	$53,504	$65,920	$77,568
Portfolio Assets Needed to Provide Annual Cash Flow	$64,946	$190,647	$343,847	$512,821	$697,144	$904,063

Our calculations are for a single individual. The savings rate we have calculated will be different, however, for a couple because the couple has a longer joint life expectancy than a single individual and the retirement income for a couple must last longer than for a single person. This is somewhat offset by the positive effect of spousal Social Security benefits, which decreases the need for accumulated capital. We suspect the spousal benefit more than offsets the costs of longer life expectancy but this will require additional research to verify.

Savings Required to Build Capital to Provide Retirement Cash Flow

Building capital consists of two components: savings and investment returns. The analysis solved for the savings rate. To estimate investment returns, the study used a Monte Carlo simulation (see the sidebar, "Why Use Monte Carlo Simulations?"). This approximates the uncertainty experienced by investors and therefore their chance of achieving their desired retirement outcome.

Our Monte Carlo simulation employs several parameters:

- Current age
- Retirement age
- Current income level
- Income growth rate
- Current portfolio amount
- Income replacement ratio
- Portfolio asset allocation

The retirement age is fixed at 65. Current age ranges from 25 to 60 with 5-year increments and current income level from $20,000 to $120,000 at increments of $20,000. Income or gross salary is assumed to grow at the same rate as inflation (2.5 percent). A change in any of these many assumptions that drive the projections will obviously change the results.

We assumed individuals invest their savings to match the asset allocation of a typical target maturity fund. Target maturity funds are a variation on so-called "lifestyle" funds, which start more aggressively and then adjust the asset allocation to be more conservative, with rebalancing as time goes by. The asset allocation of the target maturity portfolio we used follows the average allocation of the current target maturity mutual funds available. For a person at age 35 (with retirement in 30 years), the asset allocation will be 86 percent stocks and 14 percent bonds. Five years later, his asset allocation will be adjusted to 81 percent stocks and 19 percent bonds. Table 4 shows the allocations of three target maturity funds and the average of the three that we used in the analysis.

Table 4: Stocks and Bonds Allocations Across Target Maturity Funds

Provider	Years to Retire	35	30	25	20	15	10	5	0
Provider A	Stock	90%	86%	82%	76%	70%	55%	45%	45%
	Bond	10%	14%	18%	24%	30%	45%	55%	55%
Provider B	Stock	100%	93%	93%	88%	80%	75%	68%	60%
	Bond	0%	7%	7%	12%	20%	25%	33%	40%
Provider C	Stock	84%	78%	69%	59%	54%	49%	40%	33%
	Bond	17%	22%	32%	41%	46%	52%	60%	68%
Average	Stock	91%	86%	81%	74%	68%	60%	51%	46%
	Bond	9%	14%	19%	26%	32%	41%	49%	54%

Allocations obtained from the prospectus of each fund in August 2005.

For simplicity, two basic asset classes—stocks and bonds—are used in this study. The asset class investment returns are the December 2005 Ibbotson Associates estimated long-term expected returns. Table 5 shows the expected arithmetic average return and the standard deviation for each asset class, and the correlation of stocks and bonds is estimated to be 0.203. The forecasted inflation is 2.5 percent.

Table 5: Long-Term Expected Return and Standard Deviation

Asset Class	Benchmark	Expected Returns	Standard Deviation
Stocks	S&P 500	10.96	20.22
Bonds	LB Gvt/Credit	4.59	7.20

The correlation between the two series is estimated to be 0.203.

Ibbotson Associates December 2005.

We assume that, on average, the investment funds can generate the returns equivalent to index returns as shown in Table 5 after expenses and fees (see sidebar, "Returns in Real Life"). The detailed mathematics for the Monte Carlo simulation are described in Appendix B. Two thousand simulations for each one of the combinations of age (25 to 60 at increments of 5 years), income level ($20,000 to $120,000 at increments of $20,000), and savings rate (0 percent to 150 percent at increments of 0.2 percent), in total 2,000 x 8 x 6 x 751 = 72,096,000 simulations were run in this study to extract needed results shown in Tables 1 and 2. Saving contributions are added to the portfolio at the end of each year. The 90 percent probability occurs when the savings rate is sufficient to provide the necessary capital to meet the retirement income needs in 90 percent of the simulations. For example, with 2,000 simulations there are 1,800 runs in which the accumulated wealth at retirement exceeds the total retirement requirements.

Determining retirement cash-flow needs and calculating savings rates are interdependent. Adopting the savings rate changes net income, and therefore retirement replacement income. This complicates the mathematics somewhat, as we must solve for the optimal savings rate and net income simultaneously. Appendix A explains this in more detail.

Results

Table 1 shows the savings rates for 80 percent and 60 percent of gross income replacement. These assume 90 percent probability of success in accumulating the required capital. This table has two dimensions: age and income level. Not surprisingly, the savings rate to meet 60 percent replacement is significantly less than 80 percent. This is similar to the approach used by Walsh, though we used Monte Carlo for portfolio returns.

The better approach is to apply the replacement ratio against net income, which is gross income minus retirement savings, rather than against gross savings as shown in Table 1. Net income better balances current spending with retirement income. Once again we used the 80 percent replacement ratio. The results are shown in Table 2. The savings rates are considerably lower than if annual savings are not factored in, as retirement living expenses are lower.

In Table 2 we have added another column so a person can take credit for capital already accumulated. This table has three dimensions: age, income level, and capital already accumulated. To determine the guideline saving rates for an individual's situation, look up the recommended saving rate on the row showing their age and income. From this, for each $10,000 of retirement assets already accumulated, subtract the indicated amount shown in column 4. For example, an individual at age 35 with income of $40,000 a year and who is starting a saving program needs to save 12.2 percent of their gross salary. If they had already saved $10,000, they would reduce the savings rate by 0.86 percent to 11.34 percent of their gross income. If they had already saved $50,000, they would reduce the savings rate by 4.3 percent to 7.9 percent of their gross income.

As another example, assume a 55-year-old with $100,000 of income has accumulated $500,000 of retirement assets. Then this individual would have to save (40.2% – 50 x 0.4%) or 20.2 percent per year of income. The numbers at the older ages may seem unattainably high, but the savings rates are dramatically reduced by having sufficient prior wealth.1

For persons with age and income falling between the numbers shown in Table 2, a pro-rata method is a good approximation. For example, a 37-year-old with income of $50,000 can do the following to calculate his or her savings rate:

1. Estimate the savings rate of 35 years old with $50,000, and the number is (14.6% + 16.4%) / 2 = 15.5%
2. Estimate the savings rate for age 40 and $50,000, and the number is 16.2 percent
3. Estimate the savings rate for age 37 and $50,000, and it is 15.5% x 60% + 16.2% x 40% = 15.73%.

Individuals who receive company contributions to qualified plans, such as a 401(k), should treat the company contribution as part of their savings, thus reducing their personal contribution. For example, the individual age 35 with $40,000 income and $50,000 already accumulated should save 7.9 percent, but with a company match rate of 3 percent, needs to contribute 4.9 percent. If pensions or other incomes will be available in retirement, you can further reduce the savings rate.

Social Security benefits have a greater impact for low- and moderate-income individuals, an effect observed in Figure 1. At age 35, without Social Security, the savings rate is 26.4 percent for all income levels. Social Security benefits introduce non-linearity because the benefits favor low and moderate incomes and are capped for high-income levels. Social Security benefits lower the savings rate to 8.6 percent for an income level of $20,000, but only to 17.6 percent for an income level of $100,000. If Social Security benefits were delayed, reduced, or eliminated, an individual would need to save more to offset the loss. This is a greater risk to those low and middle income individuals most dependent on it.

Figure 1: Impact of Social Security Benefits on Savings Rate Age = 35, Initial Assets = $0

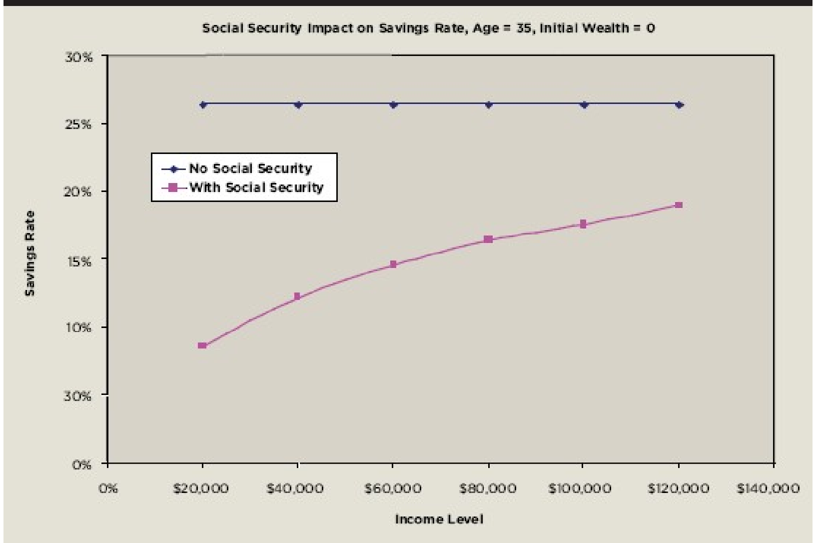

Figure 2 (next page) projects the savings rate over time for selected income levels assuming no prior capital accumulation. The slope of the savings rate curve increases after age 40 for all income levels, and indicates the benefits of starting to save early and the challenge of saving enough for retirement when savings are delayed. A person who is 35 years old and has income of $40,000 needs to save at least 12.2 percent. A person at 55 with income of $100,000, who is just starting to save, needs to put away 40.2 percent of their salary, a very difficult task for most. Because of the way Social Security works, for individuals with higher incomes the challenge is even greater. It is clear that the earlier one starts to save, the lower the needed savings rate. Those who have delayed saving and who now face a high savings rate will most likely need to search out other options, such as planning to dramatically reduce their lifestyle in retirement or delay the expected retirement date.

Figure 2: Savings Rate for Various Income Levels with 80% Net Income Replacement and 90% Probability of Success

Table 6 shows the projected capital over time an individual should have accumulated for current age and income level, *assuming he or she started saving at age 35* and followed the guidelines. Panel A of Table 6 represents the 50 percent confidence level, which is the median wealth a person should have accumulated if they have followed the savings guidelines. The Monte Carlo model is projecting that half would do better than these numbers and half would do worse.

Table 6: Projected Accumulated Wealth by Current Age for Various Income Levels at 80% Net Income Replacement

Panel A: 50% Probability

Age	Income $20,000	Income $40,000	Income $60,000	Income $80,000	Income $100,000	Income $120,000
35	$0	$0	$0	$0	$0	$0
40	$9,811	$27,836	$49,969	$74,839	$100,394	$131,425
45	$22,290	$63,243	$113,526	$170,029	$228,088	$298,588
50	$39,117	$110,984	$199,226	$298,384	$400,271	$523,991
55	$59,408	$168,553	$302,567	$453,160	$607,898	$795,793
60	$85,394	$242,282	$434,916	$651,381	$873,804	$1,143,889
65	$118,414	$335,965	$603,084	$903,249	$1,211,675	$1,586,193

Panel B: 90% Probability

Age	Income $20,000	Income $40,000	Income $60,000	Income $80,000	Income $100,000	Income $120,000
35	$0	$0	$0	$0	$0	$0
40	$7,692	$21,824	$39,176	$58,674	$78,710	$103,038
45	$16,005	$45,408	$81,512	$122,082	$163,768	$214,387
50	$26,023	$73,831	$132,533	$198,497	$266,277	$348,581
55	$37,434	$106,207	$190,650	$285,540	$383,042	$501,436
60	$51,562	$146,292	$262,607	$393,310	$527,612	$690,691
65	$68,650	$194,775	$349,637	$523,658	$702,467	$919,594

Income is gross income. Savings start at age 35.

Panel B shows the expected capital appreciated for the 90 percent confidence level. Ten percent would fall below these numbers. These projections should be considered a worst-case situation, or the minimum someone should have accumulated due to poor investment performance. Note how the numbers are dramatically lower than the numbers in Panel A with the 50 percent confidence.

The projections in Table 6 show what an individual starting at age 35 and following the guidelines is likely to have saved at various future ages. In contrast, Table 3 looks at the question of how much one needs to have accumulated to enter retirement at age 65. In other words, Table 6 starts the analysis at age 35 while Table 3 starts the analysis at age 65. Table 6 provides the benchmarks during savings, while Table 3 shows the minimum required to retire at 80 percent of pre-retirement net income.

The rows in Table 3 show gross income, amount of savings net income (which is net of saving), and 80 percent of replacement net income, which is the targeted income to receive in retirement. The table then goes on to show how much of this income is forecast to come from Social Security benefits with the remainder needing to be generated by the portfolio. Lastly, it shows the amount of capital needed to generate this income (that is, the amount used to buy the inflation-indexed annuities). Not surprisingly, the total capital needed for retirement shown in the last row of Table 3 is close to the age 65 projections of what somebody starting to save at age 35 would have accumulated at the conservative 90 percent confidence level as shown in the last row of Table 6, panel B. The logic behind it is that the savings guidelines in Table 2 allow one to accumulate enough capital with a 90 percent confidence level to buy enough inflation-indexed annuities.

Table 3 is also useful in determining what level of capital is required for a higher or lower retirement cash flow than 80 percent of net income. For example, for somebody age 65 who was earning $80,000, our model assumes they will need $53,504 of income in retirement, and they will need a portfolio of $512,821 to provide $28,252 in portfolio cash flow to supplement their Social Security. The retiree may want to increase the portfolio cash flow to a higher number such as $35,000, an increase of 24 percent. To achieve this, their retirement portfolio should also be 24 percent greater, or $635,308. Thus a person knowing what level of income they want in retirement can see how much capital they will need for retirement and bypass the model's assumption of an 80 percent replacement of net income.

Once investors determine a particular savings rate, theoretically they should be able to follow this rate until retirement at age 65. But the real world inevitably will vary from the model. Thus, individuals should check their progress over time (perhaps every five years) using information in Table 6 and adjust savings as necessary. Their eventual target should be to accumulate the assets shown in Table 3, which should be viewed as minimum levels.

If their accumulated wealth is tracking with the projections in Table 6, panel B, they probably will receive the assumed retirement income (80 percent of assumed net income), but there is little margin for error. If their accumulated wealth is tracking with the projections in panel A, there is a high probability that their retirement income will exceed the projected retirement income. They will have a large cushion for error and could either consider reducing their savings rate or continuing that rate to potentially receive higher retirement income rate.

If a person's earnings increase faster than the assumed rate in the model (such as the rate of inflation) and their expectations of retirement income also increase, the amount of capital needed to support the higher income needs in retirement may no longer be sufficient. Therefore, when their income accelerates, they may have to increase their savings rate to catch up (build additional capital) so as to be able to maintain the new standard of living once retirement occurs. In other words, they may need to save a greater portion of a pay raise than the guidelines would indicate.

Conclusions

We developed a general savings rate guideline for retirement for typical individuals with different ages, initial accumulated wealth, and income levels. We have also created a benchmark on how much capital an individual should have accumulated based on their income and age, with the presumption that they started saving at age 35. Our work differs from earlier studies in that it uses Monte Carlo simulations and Ibbotson Associates' forecasted returns to calculate capital required for retirement, and in that it calculates retirement income needs based on pre-retirement income less savings. Creation of the guidelines is very complex, both in terms of the methodology as well as the selection of the data to use. Because each individual's situation is unique, we took data as much as possible from generally accepted studies and then used software available at Ibbotson Associates to calculate results.

People should follow the savings guidelines in Table 2, which show how much to save and which provides an offset for capital already accumulated. Progress can be tracked by comparing one's accumulated savings with Table 6, with the numbers in Table 3 being the eventual capital needed as one saves for retirement. Once again, these are the minimums recommended.

These projections are for a single person. Differences for a couple will include the possibility of two pre-retirement incomes, two Social Security payments in retirement, and a longer life expectancy for the couple.

The study shows the importance of starting to save no later than age 35. It shows how higher-income people will have to save more to offset the impact of Social Security, which has a larger impact for low- and moderate-income people. Lower-income individuals who are more dependent on Social Security will also be most vulnerable to political changes in the system. Those who have failed to accumulate adequate savings will need to delay retirement or take a substantial reduction in their retirement standard of living. Finally, it suggests that those whose income increases faster than inflation will have to save an increasing amount to "catch up" so as to be able to provide for the higher assumed standard of living in retirement.

The world is ever changing. In the future, much will be different from our projections. The savings guidelines should be considered as a guide only; individuals should monitor their progress and adjust over time to ensure they reach their goals.

We developed these savings guidelines with the hope they will be publicized, generally accepted, and that once people are aware of how much they should save they will better prepare for retirement. Our intention is to make this data available for all to use.

Endnote

1. It should be noted that the deduction amount for the capital accumulated as shown in column 4 of Table 2 has some variability due to Monte Carlo simulation characteristics. In the deterministic method, the reduced rate would be exact. We calculated this deduction for each age and income level with extra $10,000 savings increments by running a regression on the simulated savings rates against the third dimension, initial wealth. Figure C1 in Appendix C shows an example for this regression for age 35 and income level of $40,000. The straight line indicates there is an approximate linear relationship between the amount already saved and the required savings rate. For example, $50,000 already accumulated reduces the savings rate by five times the savings rate for $10,000 accumulated. The reason the savings rate is not exactly linear is that the rate to be reduced due to the extra $10,000 saved in each simulation run is slightly different from another simulation. Appendix C explains mathematically why a linear relationship should hold between the savings rate and accumulated wealth.

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Disclaimer

Acknowledgment

The authors would like to thank Thomas Idzorek, CFA, and Michele Gambera, Ph.D., CFA, for valuable discussions.

Sidebars

Why Use Monte Carlo Simulations?

We used the Monte Carlo process to determine the savings rate to accumulate the capital that would be needed to generate retirement income. Monte Carlo simulations were not used for the distribution stage as this was deemed to be too complex.

The Monte Carlo process we used contrasts with the easier deterministic analysis, in which single numbers are determined for interest rates, asset returns, inflation, and so on, respectively as done by Walsh (2003). With deterministic analysis, averages are used to establish the parameters. But averages do not reflect the variability of the real world. In contrast, in Monte Carlo simulations one can specify a probability distribution for variables such as market returns, volatilities, and covariances. In one simulation path or trial, which simulates one's age from today to retirement, a series of random return numbers for each asset class are generated by following the specified variable's probability distributions. Random numbers are different in each trial, which incorporates a potential blend of economic factors, and thus each trial represents one of a number of possible investment horizon experiences. A large number of trials (for example, 2,000) then tabulate the outcomes that include risk information, alternative asset allocations, reaching retirement goals, and so on. Therefore, Monte Carlo simulation is generally considered to provide results superior to the deterministic method. Finally, Monte Carlo simulation allows the investor to view projections of possible best- and worst-case scenarios, thus helping achieve better financial decisions over a long time horizon.

In our analysis we used a 90 percent confidence limit, which is a higher hurdle than what would typically result from a deterministic model. The latter would be roughly equal to a 50 percent confidence limit. Thus, the use of Monte Carlo analysis in our work is likely to lead to higher savings amounts than other studies.

Returns in Real Life

In reality, it is likely actual returns will vary as the world is always changing and the future is not known. Additionally, even if the investment assumptions turn out to be correct, most individuals will be challenged to achieve the projected returns. The projected returns of each asset class are market returns. Because most individual investors fail to achieve market returns, most investors will probably underperform these projections. Thus, for many people the retirement income received is likely to be less than projected.

Furthermore, in real life, individuals have financial ups and downs, and during difficult periods they cut back or terminate their saving. It is difficult for someone to catch up (save more) in good times to make up for the bad times. Thus, there is a tendency to underperform the long-term projections. Additionally, nothing has been factored into the calculations to provide funds to cover late-in-life medical expenses.

Appendix A

Retirement income sources include Social Security benefits and accumulated savings, and they have to be balanced by the total required retirement income. Denote the present value of Social Security benefits and required total retirement income at retirement as B and R, respectively. The total savings at retirement is S, savings rate is s, and final salary is C. We have

$$S = R - B \qquad (1)$$
$$S = \alpha \times s \qquad (2)$$

where α is a value that is a function of periodic investment returns, inflation rate, and starting salary. S is proportional to s. The present value of total required retirement income is

$$R = \beta \times C \times (1 - s) \qquad (3)$$

where β is a value that is a function of discount rate and mortality rates.

To illustrate α and β, we give an example of three-year savings and three-year retirement scenarios. Assuming the portfolio returns are 10 percent, 5 percent, and 8 percent for the three years, savings rate is s, and salary is \$40,000 for the first year, \$41,000 for the second year, and \$42,025 for the third year, given that the inflation rate is 2.5 percent. The savings amount at the end of the third year is

$$S = 40{,}000 \times s \times 1.1 \times 1.05 \times 1.08 + 41{,}000 \times s \times 1.05 \times 1.08 + 42{,}025 \times s \times 1.08$$
$$S = (49{,}896 + 46{,}494 + 45{,}387) \times s$$

Compared with (2), we have $\alpha = 49{,}896 + 46{,}494 + 45{,}387 = 141{,}777$.

Next, assume that the discount rate is 4 percent, and the surviving probabilities for the three-year retirement are 90 percent, 60 percent, and 0 percent. The final salary is C = \$42,025. The required retirement income for the first retirement year is 80 percent of the gross income net of savings—that is, $0.8 \times (1 - s) \times 42{,}025$, the second year is $0.8 \times (1 - s) \times 43{,}076$, and the third year is $0.8 \times (1 - s) \times 44{,}153$. Considering the surviving probabilities for the three retirement years, the present value at the beginning of the retirement is

$$R = 0.8 \times (1-s) \times 42025 \times 0.9 + \frac{0.8 \times (1-s) \times 43076}{1+0.04} \times 0.6 + \frac{0.8 \times (1-s) \times 44153}{(1+0.04) \times (1+0.04)} \times 0.0$$
$$R = (30258 + 19882 + 0) \times (1-s)$$

Compared with (3), we have

$$\beta \times C = 30{,}258 + 19{,}882 + 0 = 50{,}140.$$

Substitute (2) and (3) into (1), we have

$$\alpha \times s = \beta \times C \times (1 - s) - B. \qquad (4)$$

Arrange terms for equation (4) and the savings rate is

$$s = \frac{\beta \times C - B}{\beta \times C + \alpha}. \qquad (5)$$

It can be seen that the solution for s is unique, and s is always less than 100 percent. In Monte Carlo simulation, a binary search method can be used to find the savings rate at 90 percent probability of success because s is unique and increases monotonically with the probability of success. For example, try a savings rate of 80 percent, and the probability of success may be 100 percent. Try a second savings rate of 5 percent, and the probability may be 50 percent. The third try is (80% + 5%) / 2 = 42.5%, and so on, until 90 percent probability is achieved.

Appendix B

The simulated returns are generated annually following a joint log-normal independent and identical distribution. Each asset class is assumed to follow a geometric Brownian motion, and its return, r, over a year is[1]

$$r = \mu + \sigma \times \varepsilon \quad (6)$$

where μ is the expected mean return, and σ is the asset class volatility (that is, standard deviation). ε is a random number from a standardized normal distribution (that is, a normal distribution with a mean of 0 and standard deviation of 1.0). For two asset classes, r, μ, and ε are vectors with two elements corresponding to stocks and bonds, and σ is a more complicated 2×2 matrix that satisfies

$$\sigma \times \sigma' = V \quad (7)$$

where V is the variance-covariance matrix of stock and bond, σ' is the transpose of the matrix σ. One can apply Cholesky decomposition to solve σ so that the generated return series for stocks and bonds will have correct means, standard deviations, and correlation.

Endnote

1. Can be found in general financial textbooks. For example, Hull, J. Options, *Futures, and Other Derivatives:* 226.

Appendix C

Following formula (4) in Appendix A, in which the initial wealth is \$0, assuming that the investment returns over the savings horizon are $r_1, r_2, \ldots r_T$ (T is the time for retirement), and the initial wealth is W, we have

$$\alpha \times s + \delta \times W = \beta \times C \times (1 - s) - B \quad (8)$$

where

$$\delta = (1 + r_1) \times (1 + r_2) \ldots \times (1 + r_T) \quad (9)$$

For the three-year savings example given in Appendix A, $\delta = 1.1 \times 1.05 \times 1.08 = 1.274$.

$$s = \frac{\beta \times C - B}{\beta \times C + B} - \frac{\delta}{\beta \times C + \alpha} \times W \quad (10)$$

where

$$\frac{\delta}{\beta \times C + \alpha} > 0$$

Therefore s is negatively linear with W, indicating that the more you have accumulated, the lower the savings rate.

Figure C1: Impact of Initially Saved Assets on Savings Rate for Income Level of \$40,000 and Age 35