

An Analysis of Investment Advice to Retirement Plan Participants

Zvi Bodie

ABSTRACT

This chapter examines the investment advice currently provided to participants in self-directed retirement plans (401k, 403b, etc.) by financial service firms and investment advisory services. It finds much of the advice to be logically flawed and dangerously misleading. There exists a strong bias in favor of investing retirement savings in the stock market without insurance against a market decline. The paper concludes that in view of the limited ability of the general public to handle the complex task of investing for retirement, financial firms will have to design safer products with a small number of choices that are easily understood.

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Around the world the primary responsibility for providing an adequate retirement income has been shifting from governments, employers, and trade unions to individuals. Pension plans are shifting from the defined-benefit form to defined-contribution, in which plan participants must make investment decisions. Evidence abounds that people consistently make certain mistakes because of lack of knowledge, faulty logic, cognitive dissonance, and biased statistics. This chapter examines the quality of the online investment education materials and advice offered for free at websites designed specifically for people planning for retirement. The first part of the paper analyzes the content of these websites, and concludes that much of the advice offered there is misleading and potentially quite harmful. The second part considers what might be done to improve the advice and to develop better investment products.

While there are significant differences in the level of technical sophistication among the websites and optimization tools, their qualitative advice is strikingly uniform.¹ The educational materials at these websites generally agree on the following set of principles for investing money earmarked for retirement:²

- Investors should diversify their total portfolio across asset classes, and the equity portion should be well-diversified across industries and companies.
- The longer your time horizon, the more you should invest in equities.

Table 1 summarizes some of the key findings from an examination of the major websites.³

[TABLE 1 GOES HERE.]

Time Horizon and Risk Tolerance: The Trouble with Online Advice

In economic theory there is no necessary connection between a person's time horizon and her risk tolerance. Thus, one can have a horizon of 30 years and be extremely averse to risk, or a horizon of one year and be very tolerant of risk. Indeed, for utility functions that exhibit constant relative risk aversion (CRRA), Merton (1969, 1971) and Samuelson (1969) have shown that the proportion of total wealth optimally held in risky assets is the same regardless of age. Their models show that very risk-averse people should choose to invest in such a way as to minimize the volatility of their lifetime consumption flow. If a risk-free lifetime annuity is available, then they should purchase it.

Stocks for the Long Run

Yet the standard advice offered by the financial services industry is that a longer time horizon implies greater risk tolerance.⁴ For example, *SmartMoney University* puts it this way:⁵

WHERE TO INVEST your retirement savings shouldn't be that complicated. It depends largely on a single factor: time. The more time you have before you plan to retire, the more aggressively you should be invested in equities. If, as for many people, the stock market makes you nervous, check out [Time vs. Risk](#) for an interactive demonstration of why this simple axiom holds true in good times and bad. History shows quite clearly that equities are your best long-term investment option.

A popular rule of thumb says that the fraction of one's portfolio to invest in stocks should be 100 minus one's age. Using this rule, 70 percent of one's investments should be in stocks if one is 30 years old; 30 percent should be in stocks if one is 70. The reasoning behind this advice goes as follows:

"...stocks' year-to-year volatility make them poor choices to finance short-term goals: For example, stocks' spectacular 1995 return of 37.6 percent (as measured by the S&P 500) compares with the low 1994 return of 1.3 percent. But, over longer periods of time, fluctuations like these have tended to settle down -- as you can see in the chart. Stock returns for twenty-year periods ranged from a low of about 3 percent to a high of around 17 percent. Over thirty-year periods, stock returns narrowed, ranging from 8.5 to 13.5 percent. That's why, although investing in stocks is hardly risk-free and past results certainly don't guarantee future performance, their historical pattern suggests that stocks may be an appropriate alternative for you to consider if your goal is a longer-term one."⁶

Unfortunately, this reasoning is invalid and may be dangerously misleading. The apparent reduction in risk is a statistical illusion arising from the fact that the measure of return used is an average compound rate. As students of introductory statistics are taught, the dispersion of an N-year average declines as N grows.⁷ But the dispersion of the average compound rate of return is not a relevant parameter for the purpose at hand. For a person investing a lump sum now to have, say, \$1 million in 30 years time, the relevant parameter is not the dispersion of the annual rate of return, but the dispersion of the value of the portfolio in 30 years.

This same mistake is often made in educational materials depicting the tradeoff between risk and reward (the "efficient portfolio frontier") for different time horizons. Using mean and standard deviation of average compound rates of return, the slope of the curve gets steeper as the time horizon lengthens, implying that equities are a better choice the longer one's horizon. But this is because the expected annualized risk premium remains fixed, while the annualized standard deviation declines: again, a statistical illusion.⁸

The financial advice websites that report probability of success or failure as their summary measure are also misleading, but in a more subtle way. To see why, compare the *probability* of a shortfall with the *cost of insuring* against a shortfall.⁹ A shortfall occurs if the value of a stock portfolio at the horizon date is less than the value an

investor would have received by investing in safe bonds (e.g., Treasury bonds) maturing on that same date. If, as history suggests, the *expected* average compound return on stocks exceeds the risk-free rate of interest, it is indeed *true* that the probability of a shortfall declines with the length of the investment time horizon (See Figure 1). But this fact does not have the favorable implications many investment advisers think it has.

[FIGURE 1 GOES HERE.]

The Truth About the Risk of Stocks in the Long Run

The simple economic fact is that there is no free lunch for the long-term investor in the risk-reward department. The probability of a shortfall is a flawed measure of risk because it completely ignores the *severity* of the financial loss should a shortfall occur.¹⁰ A measure that does take proper account of *both* the likelihood *and* the severity of a potential shortfall is the price an investor would have to pay to insure against it. If stocks were truly less risky in the long run, then the cost of insuring against earning less than the risk-free rate of interest should decline as the length of the investment horizon increases.

But reality is quite the opposite. The structure of insurance against shortfall risk is effectively a *put* option with maturity equal to the investment horizon and with a strike price set at the *forward* price of the underlying stock portfolio.¹¹ According to theory and in actual practice, the put price representing the cost of insuring against a shortfall *increases* as the investment horizon lengthens. (See Figure 2).

[FIGURE 2 GOES HERE.]

This pattern is easily confirmed for maturities up to 3 years by inspection of prices for exchange-traded puts on individual stocks and on broad stock-index portfolios. The same result holds uniformly for proprietary pricing models used by investment and commercial banks to assess their own cost for longer-maturity puts that they sell over the counter. For very long maturity puts, this cost ranges from one-third to a half of the value of the equity portfolio to be insured and so there is typically little commercial interest. In short, the insurance cost, and hence the risk, of shortfall over long time horizons is anything but small. (See Bodie (1995) and LaChance and Mitchell (this volume).)

The Importance of One's Earnings Profile

Thus we see that the conventional reasoning linking age and equity investing is fundamentally flawed. But there are *good* reasons for linking age and portfolio mix. A critical, but often overlooked, determinant of optimal asset allocation is the risk profile of the individual's future labor income. Typically the ratio of future labor income to other assets (such as retirement savings) is large when investors are young, and eventually it decreases as they approach retirement. If one's future labor income is relatively secure, it *may* be optimal to start out in the early years with a high proportion of one's investment portfolio in stocks and decrease it over time as suggested by the conventional wisdom.

However, this conventional wisdom may *not* apply to those who face substantial risk in their labor income -- entrepreneurs or stock brokers, for example, whose income is highly sensitive to stock market risk. For such investors, their human capital already

provides a large stock market exposure and the *opposite* policy may be optimal, i.e., to start out with a relatively low fraction of the portfolio in stocks and increase it over time.¹²

The Conservative Investor

To assess the strength of the pro-equity bias at websites for retirement plan participants, I performed a simple test by adopting the stance of an ultraconservative investor to see if there was any mention of risk-free investments, such as inflation-protected bonds. When asked questions designed to elicit my risk tolerance, I answered them in such a way as to indicate as little tolerance as possible for risk of any kind. In theory, the financial advice should result in a portfolio designed to minimize the volatility of my lifetime consumption. If all post-retirement consumption is to be financed from accumulated savings, then the portfolio should consist entirely of fixed-income securities denominated in units of the consumption good.

In *none* of the many models I tested did this ever turn out to be the case. Instead, I was always advised to invest a substantial fraction of my portfolio — at least 30% -- in stocks. This was true even when I notified the advice program that I was starting my retirement. As shown in the next section, retirees who are drawing down their retirement savings to finance their spending, face special risks when they invest in equities.

The Situation of Retirees

Most websites emphasize the fact that people may live a long time after they retire. The average male retiring at 65 can expect to live 19 more years, to age 84. The average woman retiring at age 65 can expect to live 23 more years, to age 88. Therefore, the reasoning goes, one should remain substantially committed to stocks even after one retires.

This advice is especially problematic, however, because during retirement one is drawing down one's assets. The resultant standard of living will depend not only on the *average* rate of return one earns during retirement, but also on the *time path* of returns. Even if the average rate of return is high, one can run out of money long before one expires. For example, suppose one planned to save a total of \$1 million, expecting to live for 20 years after retirement, and assume an average rate of return of 10% per year.¹³ The annual retirement income to be withdrawn is calculated to be \$117,496 per year. Table 2 shows that by withdrawing this amount at the end of each year, the original fund will be exhausted in precisely 20 years, *provided that one earns 10% in each and every year.*

[TABLE 2 GOES HERE.]

But suppose that the rate of return varied over the 20 years. Even if the average is 10% per year, it makes a big difference whether the higher-than-average returns occur early or late in the 20-year span. Suppose that during the first 10 years your rate of return is below average and during the last 10 years it is above average. One might not make it past the 10th year. For example, suppose the rate of return is zero in the first 10 years, and 20% per year in the last 10 years. Since the fund would earn no interest at all during the first half of the period, one would completely run out of money by the 9th year, as shown in Table 3 and in Figure 3.

[TABLE 3 AND FIGURE 3 GO HERE.]

This is not merely a far-fetched hypothetical situation. Suppose that in January 1973 a retiree had a fund of \$1 million. The average rate of return on a value-weighted portfolio of all stocks on the NYSE during the 20 years starting in 1973 was a healthy 12.78% per year. Suppose the retiree was conservative and assumed only a 10% rate of return, thus taking out \$117,460 each year. The pattern of actual annual returns and remaining funds is shown in Table 4 and depicted in Figures 4 and 5.

[TABLE 4 AND FIGURES 4 AND 5 GO HERE.]

Let's take a detailed look at what happened. The stock market declined 14.75% in 1973, so at the end of the year only \$852,500 was left. After taking out \$117,460, only \$735,040 was left. In 1974 the market dropped another 26.5%, reducing the account balance to \$540,990. At the end of 1974, he again took out \$117,460, leaving a new account balance of \$423,530. In other words, by the end of 1974, he had less than half of the original \$1,000,000 left, even though he only took out a total of \$234,920. In 1975 the market gained 37.2%, lifting his balance to \$581,337. After withdrawing \$117,460, the balance was \$463,878. In 1976 the market climbed 23.8%, raising the balance to \$575,116, from which he again took \$117,460, leaving a balance of \$457,656. The next year, 1977, was a bad year with a market return of -7.2%. The account balance declined to \$424,430, from which he withdrew \$117,460, and so on. By the time he reached 1981, he had only \$56,514 left in the fund. That year his return was -4.98% and he could no longer take out \$117,460 to live on. Thus we see that even though *on average* from 1973 through 1992 the market returned a rate of return of 11.3% per year, and he had been counting on only 10% per year, he ran out of money before the 10th year.

Matters would have been even worse for a retiree in Japan. The Japanese market reached its peak in 1989 -- just over 40,000 on the Nikkei 225, its major stock index. It then plunged to about 12,000, and despite temporary recoveries it has remained depressed.

Differences of Opinion Among Expert Forecasters

How will the U.S. stock market perform over the next 10 years? Even the experts cannot agree. The *New York Times* (September 2, 2001) reported that Robert Shiller and Jeremy Siegel, two finance professors who specialize in analyzing the stock market had strikingly different market forecasts. Shiller argued that the US stock market was vastly overvalued, and he predicted generally poor performance until share prices realign themselves with "fundamental" values. Siegel disagreed. If the experts cannot even agree about the *mean* rate of return on stocks over the next decade, then it is reasonable to conclude that even a well-diversified stock portfolio is a risky investment.

Another piece of conventional wisdom holds that one should invest in stocks because they are a good hedge against inflation. In fact, the evidence is that stocks are not a good hedge against inflation. The decade of the 1970s was the only prolonged period in the past century when the US experienced significant inflation, and that is precisely the period when stocks did poorly.¹⁴

Defined-Benefit, Defined Contribution, and Individual Choice

One institutional response to the difficulties faced by ordinary people in managing their own retirement funds has been defined-benefit pension plans. In a typical defined-benefit plan for salaried employees, those who work for the organization sponsoring the plan over their whole career receive a guaranteed life annuity that replaces 60-70% of final salary.¹⁵ The employee "pays" for this annuity by working for the organization for a

certain minimum number of years. Plan participants do not worry about the risk of a shortfall, since this is the concern of the sponsor and in the U.S., the Pension Benefit Guaranty Corporation.¹⁶

But traditional defined-benefit pension plans have been on the decline in the U.S., eclipsed by cash-balance plans and defined-contribution plans, which transfers the risk to those who may be least qualified to manage it.¹⁷ For the average participant in an employer-sponsored plan, the switch to self-directed pension plans might therefore cause a decline in welfare, even when offset by other benefits of greater monetary value.

The tendency in the last several years has been to offer participants in self-directed retirement plans more and more investment options. Economists generally believe that people are made better off when offered more choices, as long as they can always choose what they had before.¹⁸ But when people do not have the knowledge to make choices that are in their own best interests, increasing the number of choices may not necessarily make them better off. In fact, it could make them more vulnerable to exploitation by opportunistic salespeople or by well-intentioned but unqualified professionals.

An analogy with medical care may clarify this point. Most of us look to physicians and other medical professionals to guide our choices about health maintenance practices and treatments for illnesses. We would probably not be better off if the number of alternatives increased without our understanding enough about them to make rational choices. Like surgery, asset allocation is a complex procedure, requiring much knowledge and years of training. No one would imagine that patients could perform surgery to remove their own appendix after reading an explanation in a brochure published by a surgical equipment company. Yet current practice seems to expect people to choose an appropriate mix of stocks, bonds, and cash after reading a brochure published by an investment company. Some of them are likely to make serious mistakes, and the educational materials distributed to retirement plan participants by financial service firms confirms these fears. Participants are led to believe that stocks are not risky in the long run. Online asset allocation tools are heavily biased towards equity investment. Rarely is mention made of truly safe long-term investments such as government inflation-protected bonds and real annuities.

Protection Against a Market Decline

Starting with the emergence of exchange-traded options and the discovery of the option pricing model in 1973, a variety of financial service firms have been selling investment products that offer protection against a stock market decline.¹⁹ In Germany it seems likely that insured equity-linked retirement saving products will become the norm as a result of the pension reform legislation passed in 2001. A key feature of Germany's pension reform is that to qualify for state subsidies, all savings vehicles must carry a guarantee of principal.²⁰

Escalating Life Annuities

The modern theory of contingent claims analysis provides the framework for the production and pricing of new and improved retirement income products with protection against both market declines and the risk of outliving one's resources.²¹ Let me illustrate using the example of a class of contracts that I call "escalating annuities."²²

Traditional annuities in the United States, including those provided by defined-benefit plans have a glaring defect – they are not protected against inflation. Today it is possible for financial intermediaries to efficiently produce annuities that are protected fully or partially against inflation by hedging the liability with inflation-protected government bonds.²³ Moreover, they can also be combined with upside participation in the performance of various stock market indexes. As an example, consider an escalating life annuity with a minimum benefit linked to the cost of living. Payments increase with inflation and with the performance of a market index, and increases are locked in for life.

Escalating annuities are designed to provide a guaranteed minimum standard of living defined in terms of a flow of lifetime consumption (rather than a stock of wealth). They allow retirees to gradually increase their consumption if the stock market performs well without jeopardizing the standard of living to which they have become accustomed. Note that this is very different from a variable annuity benefit, which can either go up or down over time depending on market performance.

To make the example more concrete, let us assume that a typical customer reaches age 65 with \$1 million in her self-directed retirement account. She wants to retire and live off her income from Social Security (say \$15,000 per year) and the income generated by her \$1 million retirement account. How would a hypothetical escalating life annuity work?

One simple design would be to allow the annuitant to choose the fraction of her \$1 million that would go into the guaranteed real annuity. Assume she chooses 90%, and that this establishes a guaranteed real floor of \$55,000 per year.²⁴ Together with her Social Security income, this gives her a real income floor of \$70,000 per year. The other \$100,000 in her retirement account would be invested in equities or equity derivatives to produce growth in real income. Each year part of this risky fund would be used to purchase additional guaranteed real annuity income.²⁵

The upside leverage of the escalating annuity could be increased by investing the \$100,000 at risk in a series of equity call options maturing in each of the next 10 years. If on the annual expiration date, the call is in the money, then the proceeds are used to increase the guaranteed income floor. If it is out of the money, the floor remains unchanged for another year.

Currently, exchange-traded options have maturities as long as three years. Firms that sell structured equity participation securities have issued notes with maturities of 10 years. It is not hard to imagine that innovative firms might issue even longer-dated index call options over the counter.

Conclusion

Increasingly, the complex problem of investing so as to provide a secure retirement income is being transferred from governmental institutions and private-sector employers to people who have neither the knowledge nor the training to handle the risk. As we have seen, the educational materials and investment advice provided to those people by financial service firms is dangerously misleading. One practical solution to the dangers posed for individuals and for society at large is to design and produce a new generation of investment products that insure people against severe market declines. Advances in the science of finance and market innovations over the past several decades have made this a feasible task.

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Table 1. Retirement Investment Advice at Websites

<i>Issue</i>	<i>Quicken</i>	<i>Smart Money</i>	<i>mPower (Money Central)</i>	<i>Financial Engines</i>
Does the fraction in stocks automatically increase with time horizon?	Yes	Yes	No	No
Is there a risk-free (e.g., TIPS or I-bonds) option?	No	No	No	No
Is there any mention of different stock market forecasts of experts?	No	No	No	No

Table 2. Drawdown of Retirement Fund Assuming 10% per year Rate of Return

Year	Rate of return	Amount in fund	Interest earned	Amount withdrawn
1	10%	\$1,000,000	\$100,000	\$117,460
2	10%	\$982,540	\$98,254	\$117,460
3	10%	\$963,335	\$96,333	\$117,460
4	10%	\$942,209	\$94,221	\$117,460
5	10%	\$918,970	\$91,897	\$117,460
6	10%	\$893,407	\$89,341	\$117,460
7	10%	\$865,288	\$86,529	\$117,460
8	10%	\$834,358	\$83,436	\$117,460
9	10%	\$800,334	\$80,033	\$117,460
10	10%	\$762,907	\$76,291	\$117,460
11	10%	\$721,739	\$72,174	\$117,460
12	10%	\$676,453	\$67,645	\$117,460
13	10%	\$626,638	\$62,664	\$117,460
14	10%	\$571,843	\$57,184	\$117,460
15	10%	\$511,567	\$51,157	\$117,460
16	10%	\$445,264	\$44,526	\$117,460
17	10%	\$372,331	\$37,233	\$117,460
18	10%	\$292,105	\$29,210	\$117,460
19	10%	\$203,856	\$20,386	\$117,460
20	10%	\$106,781	\$10,678	\$117,460
21		\$0	\$0	

Table 3. Draw-Down of Retirement Fund When Rate of Return During First 10 Years Is Zero

Year	Rate of return	Amount in fund	Interest earned	Amount withdrawn at end of yr
1	0	\$1,000,000	\$0	\$117,460
2	0	\$882,540	\$0	\$117,460
3	0	\$765,081	\$0	\$117,460
4	0	\$647,621	\$0	\$117,460
5	0	\$530,162	\$0	\$117,460
6	0	\$412,702	\$0	\$117,460
7	0	\$295,242	\$0	\$117,460
8	0	\$177,783	\$0	\$117,460
9	0	\$60,323	\$0	\$117,460
10	0	-\$57,137	\$0	\$117,460

Table 4. Actual Values for Retiree Starting in 1973

Year	Rate of return	Amount in fund	Interest earned	Amount before withdrawal	Amount withdrawn
1973	-14.75%	\$1,000,000	-\$147,500	\$852,500	\$117,460
1974	-26.40%	\$735,040	-\$194,051	\$540,990	\$117,460
1975	37.26%	\$423,530	\$157,807	\$581,337	\$117,460
1976	23.98%	\$463,878	\$111,238	\$575,116	\$117,460
1977	-7.26%	\$457,656	-\$33,226	\$424,430	\$117,460
1978	6.50%	\$306,971	\$19,953	\$326,924	\$117,460
1979	18.77%	\$209,464	\$39,316	\$248,780	\$117,460
1980	32.48%	\$131,321	\$42,653	\$173,974	\$117,460
1981	-4.98%	\$56,514	-\$2,814	\$53,700	\$117,460
1982	22.09%	-\$63,760	-\$14,085	-\$77,844	\$117,460

Figure 1. Probability of a Shortfall

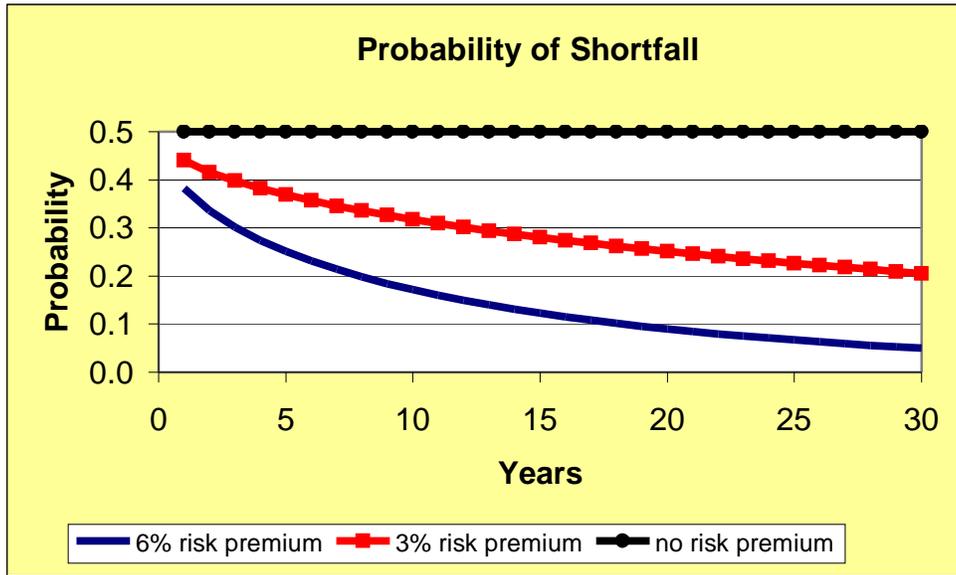


Figure 2. Cost of Shortfall Insurance

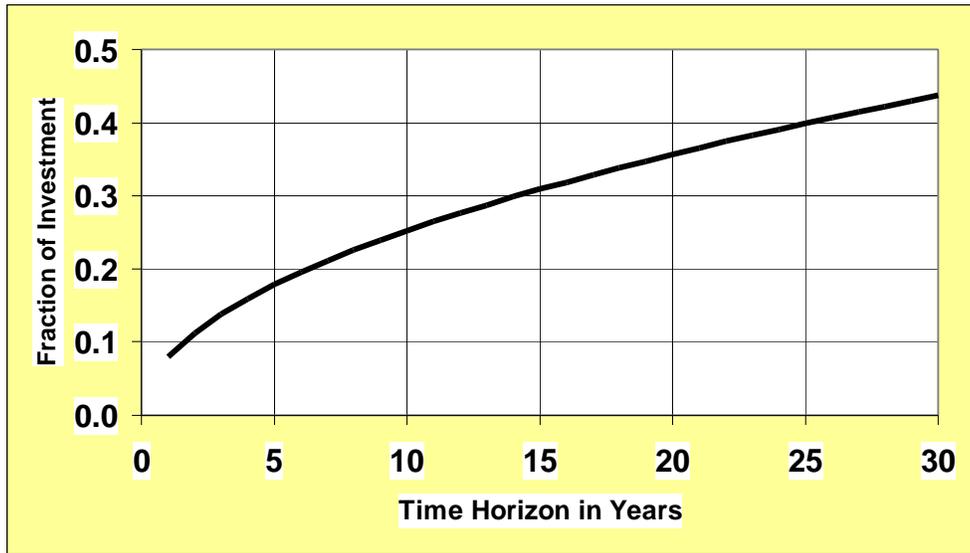


Figure 3

How Long \$1 million Will Last

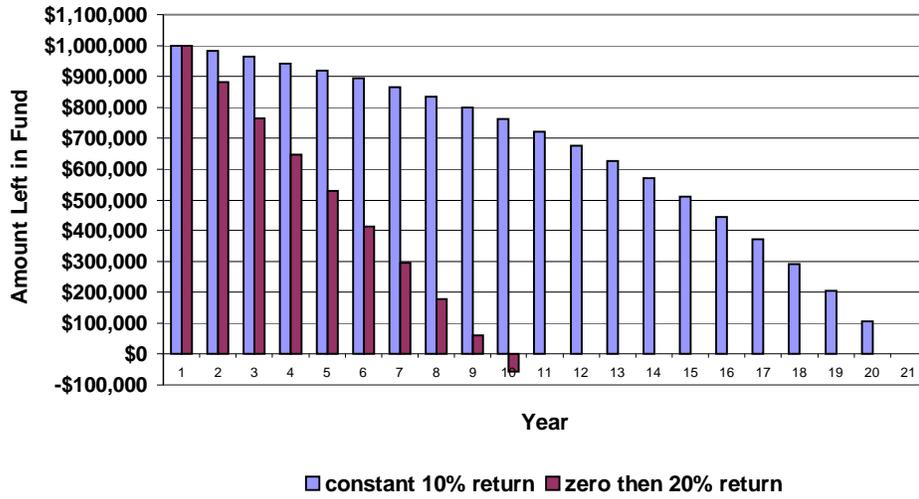
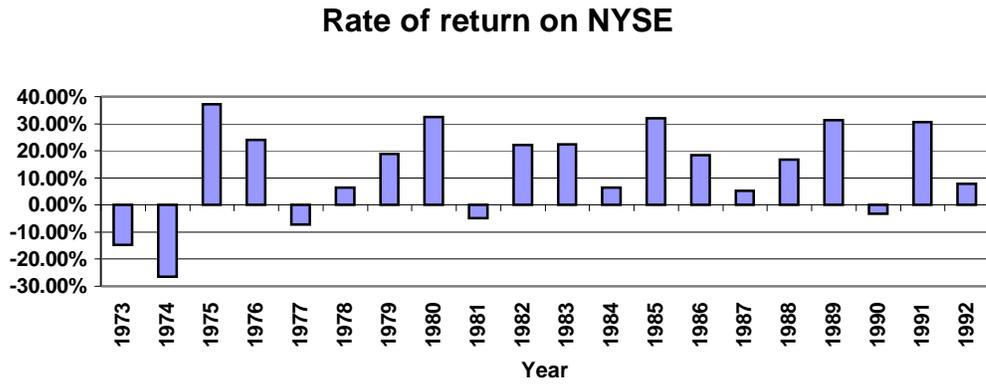


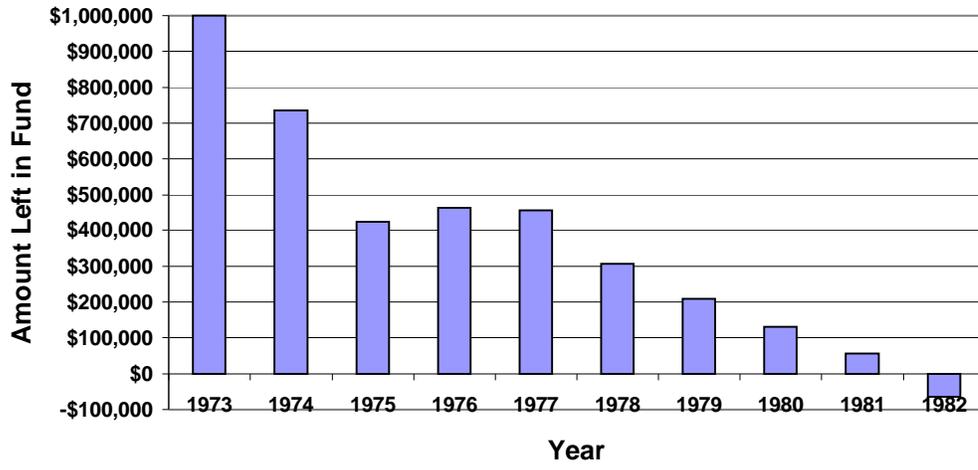
Figure 4



Data Source: [WRDS](#).

Figure 5

Retiree Who Started in 1973



Endnotes

¹ A major distinction is between websites that give advice in terms of from 3 to 5 generic asset categories and those that give more specific recommendations based upon the user's actual holdings. Some use a Markowitz efficient portfolio frontier analysis. The more sophisticated websites, such as *FinancialEngines* or *mPower*, simulate probability distributions of retirement wealth or retirement income.

² See Bodie and Crane (1997) for a more complete statement of generally accepted investment principles. Ameriks and Zeldes (2001) report a similar finding.

³ My survey was done during the month of December 2001.

⁴ *Financial Engines* was the only exception.

⁵ <http://university.smartmoney.com/Departments/Investing101/RiskvsReward/index.cfm?story=timevsrisk>

⁶ From TIAA-CREF "[Principles of Sound Investing](#)."

⁷ The variance of the annualized rate of return declines with the length of the holding period as long as there is not perfect positive serial correlation in stock returns. Empirically stock returns exhibit either no serial correlation or negative serial correlation. See pages 254-6 in Bodie, Kane, and Marcus (2002).

⁸ See Merton (1992) for a demonstration that characterizing rates of return solely in terms of mean and variance is valid only when the time interval is extremely short and there are no big "jumps."

⁹ See Bodie(1995).

¹⁰ The term *severity* as used here is meant to capture not just the *magnitude* of a shortfall but also its *weight* in terms of its Arrow-Debreu state-claim price. For a detailed discussion of this point see Bodie (2002).

¹¹Bodie (1995).

¹² See Bodie, Merton, and Samuelson (1992).

¹³ This example is taken from Bodie and Clowes (forthcoming in 2003).

¹⁴ See Bodie (1976).

¹⁵ The employer-provided benefit is typically integrated with Social Security benefits, and the combination of the two replaces roughly 70% of earnings only for those at the bottom of the income scale.

¹⁶ This guarantee is capped by the PBGC. Above the cap, the employee is at risk of default by the plan sponsor. For plans terminated in 2001, the cap was \$40,704.60 per year. It is adjusted annually.

¹⁷ The AFL-CIO writes: “Defined benefit plans remain the best and soundest vehicles for building and safeguarding retirement income and security.”

<http://www.aflcio.org/publ/estatemts/feb2002/governance.htm>

¹⁸ But even economists acknowledge that there are exceptions, for example, when people have problems with self-control. Offering a shot of whiskey to a recovering alcoholic does not increase his welfare.

¹⁹ For a discussion of such products, see Bodie and Crane (1999).

²⁰ Deutsche Bank has already structured principal-guaranteed transactions on funds of funds and mixed equity and fixed-income portfolios.

<http://www.risk.net/investor/archive/oct01/pension.htm>

²¹ For a discussion of the many other risks of old age that can be addressed with innovative financial products, see Bodie, Hammond, and Mitchell (2002).

²² Dybvig (1995) uses the term “ratcheting” to describe this time-pattern of consumption.

²³ See Bodie (1990, 1997).

²⁴ This is an approximation based on quoted rates on Lincoln National Life’s Inflation-
Proofer annuity.

²⁵ I am assuming that she has no bequest motive.