

# Life-Cycle Investing Is Rolling Our Way

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Recently, the financial planning community has focused intently on determining optimal portfolio withdrawal rates and portfolio rebalancing strategies for individual investors in a world of uncertainty. Meanwhile, the rest of the financial services industry has moved forward to a different conversation. This different conversation has far-ranging implications for our clients and our practices, and is the subject of this article. In essence, with respect to personal financial planning products, a paradigm shift has already occurred in the fields of financial economics and financial engineering, and it is now rolling rapidly toward the financial planning industry. A hallmark of this shift in perspective is the great effort being devoted to developing an updated defined-benefit pension plan substitute as a routine choice for 401(k) withdrawals.

Financial planners in this generation tend to offer advice that comes straight out of the 1950s Markowitz mean-variance model, a single-period model that relies mainly on time diversification to manage market risk and that focuses on optimizing end-of-period wealth.<sup>1</sup> That's why as an industry we tend to advise stock allocations that rise with the expected time horizon, and why we mainly emphasize diversification strategies when we design and present investment portfolios to clients. But this

## Executive Summary

- Drawing on 1950s models, the financial planning community uses mainly precautionary savings and diversification strategies to manage personal wealth. But financial economists and many others in the financial services industry have moved on to a new paradigm known as life-cycle investing.
- Life-cycle investing is a multi-period model that uses hedging and insuring as well as precautionary saving and diversification as core strategies. Personal wealth is defined as the sum of current financial wealth and the present value of an investor's human capital—that is, what an investor's labor will earn during his or her lifetime. In contrast to the current paradigm, welfare is measured by lifetime consumption, not wealth.
- The combination of life-cycle investing theory and the great innovation in

the derivatives markets since the 1970s has set the stage for a new generation of retail investment products. The new default 401(k) withdrawal may soon be an inflation-indexed annuity with a guaranteed floor and participation in market appreciation.

- Instead of talking about optimal portfolio withdrawal and rebalancing strategies, clients and their planners will focus more on how much and at what rate to annuitize financial wealth.
- At the moment, planners are uncomfortable with such widespread use of options and other derivative securities. But the implication for planners is that this paradigm shift in financial theory and product innovation is about to fundamentally change how we work with clients and how we structure our businesses.

model, and the implied optimal planning strategies, are—in the financial economists' worldview—outmoded.

What is missing in the financial planning world is an understanding that in the financial economics literature, the Markowitz mean-variance model was superseded by research published in 1969 by Nobel laureates Paul Samuelson and

Robert Merton.<sup>2</sup> Their ideas are the foundation for the theory of life-cycle investing, the focus of this article.<sup>3</sup>

Complementing this trend in the academic literature is the blossoming of financial product innovation at the institutional level. The financial product innovation began just after the groundbreaking work on option pricing theory in the early 1970s

by Robert Merton, Myron Scholes, and Fischer Black. As is now routinely explained in standard finance textbooks:

Options are an example of a broader class of assets called contingent claims. A contingent claim is any asset whose future payoff is contingent on (i.e. depends on) the outcome of some uncertain event. The Chicago Board Options Exchange (CBOE), the first public options exchange, began its operations in April 1973, and by 1975, traders on the CBOE were using the Black-Scholes formula to both price and hedge their option positions. Such a rapid transition from theory to practice on such a large scale was unprecedented in the history of finance.<sup>4</sup>

### Fundamentally Changing How Planners Work

Since the introduction of the Black-Scholes option pricing formula in the early 1970s, the market for options and other derivative securities has exploded at the institutional level, and is now in the early stages of transforming retail investment products. A recent article in *Financial Engineering News* notes that "the growth in the global derivatives market has been staggering, increasing from a notional value of US \$98 trillion in 2000 to \$270 trillion at year-end 2005." Not surprisingly, given this enormous growth, financial engineering has bloomed into a new discipline, as exemplified by the creation of new graduate degree programs, a vigorous professional society, and a weekly industry newspaper. (See [www.fenews.com](http://www.fenews.com) or simply Google "financial engineering.")

For people trained in economics, the context is that we have moved away from the pre-1950s paradigm of assigning risk (for example, where speculative investments are given to executives and safe investments assigned to widows and orphans), through the 1950s to the 1970s modern portfolio theory paradigm (where risk is controlled mainly by diversification), to the emerging dominant paradigm (where risk can be segregated and traded

**Table 1: Summary of Old and New Paradigm for Personal Financial Management**

Feature	Old Paradigm	New Paradigm
Measure of welfare	Wealth	Lifetime consumption
Time frame	Single period (stocks seem safe in the long run)	Many periods (stocks are risky in short and long run)
Risk management techniques	Precautionary saving Diversification	Precautionary saving Diversification Hedging Insuring
Retail financial products	Cash Insurance policies Mutual funds	Targeted savings accounts (e.g., tuition-linked certificates of deposit) Structured standard-of-living contracts
Quantitative model	Mean-variance efficiency and Monte Carlo simulation	Dynamic programming and contingent claims analysis
Capital market expectations	Estimated from historical statistics	Inferred from current prices of financial instruments (swap curves and implied volatilities)

Zvi Bodie, "Life Cycle Investing in Theory and in Practice," *Financial Analysts Journal*, January/February 2003.

to the entity most able and willing to bear that risk). In the economists' language, markets are becoming more complete.

The implication for planners is that this major paradigm shift in financial theory and product innovation is about to fundamentally change how we work with clients and how we structure our businesses.

Of particular note is that professional education is already being updated for other members of the financial services industry. For example, the tenets of life-cycle investing were recently introduced into the continuing education literature for Chartered Financial Analyst designees. (See Table 1 and references to other CFA Institute publications in the footnotes.<sup>5</sup>) Life-cycle investing is also a core part of the finance curriculum for this generation of business school graduates—including, for example, the new MBA staff members in your firm.<sup>6</sup> But, interestingly, it is not yet fully incorporated into the financial planning literature.

### Focus on Lifetime Consumption

Life-cycle investing is an approach to managing individual wealth that is based on the now current theoretical understanding of personal finance and the product innovations made possible by the translation of option theory to financial product innovation at the institutional level. In life-cycle

investing the main measure of financial well-being is lifetime consumption, not wealth. Thus, life-cycle investing is a multi-period model that uses hedging and insuring, as well as precautionary saving and diversification, as core strategies for managing personal wealth.

This contrasts with the current paradigm, which focuses mainly on optimizing end-of-period wealth, using mainly precautionary savings and various diversification strategies.

Under life-cycle investing, investors' personal wealth is specifically defined to be the sum of current financial wealth and the present value of their human capital—that is, what their labor will earn during their lifetime. Not surprisingly, then, coordination of portfolio strategies with the expected risk and return of one's human capital is a central consideration.

The hallmarks of the old and new paradigm are summarized in the chart created by financial economist Zvi Bodie (see Table 1).

As Table 1 illustrates, the risk management techniques of the new paradigm are very different from the old paradigm approach of saving as much as possible and then hoping that, because mainly of diversification strategies, the portfolio will last for the whole of retirement regardless of trends in personal spending, longevity, inflation, and investment volatility. This different point of view is also becoming

practical and reasonable, as well as theoretically correct, because product innovation is creating personal finance products that address these specific desires.

### Future Life-Cycle Products

A peek into the future under the new paradigm would reveal a variety of new personal finance products. Most obvious would be a lifetime inflation-indexed annuity, with a guaranteed floor and some participation in market appreciation—a so-called “structured standard of living” product. Bells and whistles could include an ability to annuitize gradually, or in some partial amount, and also with some reversibility.

A further idea is to bundle an inflation-indexed annuity with long-term care insurance in order to eliminate adverse selection. Economist Mark Warshawsky documents large savings if healthy people, who tend to buy annuities, and unhealthy people, who tend to buy long-term care insurance, are pooled together as purchasers of one bundled product.<sup>7</sup>

It is sobering to think through how just this one life-cycle investing product could change our planning practices. Instead of talking mainly about optimal portfolio withdrawal rates and rebalancing strategies, we'd be talking a lot more with our clients about how much of, and at what rate, and with what investment products, to annuitize the portfolio, and also a lot more about how to protect and enhance human capital. In this context, unprotected stock investing—that is, portfolios that rely solely on diversification as the precautionary measure against investment losses—would become distinctly more uncomfortable, as would charging advisory fees as a percentage of the portfolio.

In the current transitional period, we are already seeing early versions of life-cycle investment products. Several of the larger insurance companies have come out with structured standard of living contracts that offer lifetime annuitized income, with guaranteed floors and

(capped) participation in equity appreciation. As many planners correctly point out, however, these early products carry some of the flaws of the old paradigm, such as confusing pricing that is difficult to competitively shop, unclear consumer protections and guarantees, fine-print contract language that could significantly lower the value to the consumer of the product, and incomplete inflation protection, as well as non-optimal tax consequences. [Editor's note: For the pro and con opinions of financial planners on new types of guaranteed annuity contracts, see Nancy Opiela's article, “Variable Annuities: Emerging from the Dark Side?” in the March 2007 issue.] In addition, planners reasonably question what happens if the insurance company declines in financial health, or does not succeed in attracting a sufficiently large client pool, and also how planners would responsibly monitor such an investment. For example, how would the planner recognize if the company strayed from the planned financial engineering to making big market bets?

There is also concern in the planning community that an inflation-indexed annuity bundled with a long-term care insurance product would mainly represent an opportunity for the insurance companies to overprice the contract, as has been the historical pattern with bundled insurance products, even though economists can demonstrate the power of bundled products to lower the risk of adverse selection.

On an even more basic level, planners question the practicality of calculating personal wealth as the life-cycle model suggests, since the human capital part of the equation would seem to be a moving target as career and life changes are made.<sup>8</sup>

And finally, and perhaps most importantly, there is clearly dissonance between the lack of awareness and trust in options and other derivative securities by planners and the detailed understanding of, and high comfort level with, these securities by economists.

For planners, it can be tempting to brush these products aside, relying on the notion

that in the past, annuities—especially bundled annuities—were not products that value-conscious advisors would be using, and that in general, staying away from insurance-based investment products is a prudent business strategy that also protects the client's best interests.

In contrast, financial economists and the large financial institutions and their growing staffs of financial engineers have a high degree of comfort with synthetic securities and also great optimism about the next generation of personal financial investment products. For example, in a recent speech, Nobel laureate Robert Merton expressed optimism that the financial theory developed in the 1970s, and now thoroughly tested at the institutional level in actual financial products since the 1990s, will soon lead to the next generation of personal finance products.<sup>9</sup>

Professor Merton noted, for example, that there will likely be compelling consumer demand for the ability to have some reversibility in contracts such as annuity products. But his immediate follow-up comment was that in the realm of financial engineering, this simply means embedding a “look-back” option into the annuity contract, and that look-back options are a very standard part of the derivatives markets. In fact, Merton notes, look-back options have been in use at the institutional level for decades after having become well established in the economic literature in 1979.

### Converging Threatening Trends

Where planners and economists do agree is that several trends are converging at this time to greatly complicate, and even threaten, the individual investor's quest for lifetime financial security. The most commonly cited trends include

- The shift from defined-benefit to defined-contribution pension plans
- The lessening role of Social Security benefits
- The increasing cost of health care, especially for retired people
- The impact of inflation, increasing

longevity, and the shrinking equity premium

- The low savings rate of the American population

In response, financial economists are striving to reinvent the defined-benefit pension plan in some sensible form for the modern world, which likely means a structured standard-of-living contract offered as a routine choice for 401(k) withdrawals. The rationale is that distributing structured standard-of-living contracts, at least initially through large employers, is sensible and feasible. Plus, economic research has already documented that the default choices in retirement plans have an extremely powerful influence on consumer behavior.<sup>10</sup> Consequently, there is great energy and laser-like attention on creating a lifetime, and preferably inflation-indexed, annuity as a standard, and perhaps even the new default for withdrawals from 401(k) plans.

Actuary Anna Rappaport, for example, writes: "Today lump sums [from 401(k) plans] are the common default, and life income options are often not available. I would prefer to see a default distribution that leaves the money in the plan until age 70 and provides for paying out 4% per year as regular installments. At age 70 and for each of the next four years, annuitize 10% of the balance on a 100% joint and survivor basis. The retiree would be able to opt-out of this default option for any funds not yet annuitized."<sup>11</sup>

Meanwhile, planners are acutely aware that pensioners are vulnerable to corruption (for example, when Enron imploded from corrupt practices), to simple financial woes (such as when United Airlines succumbed recently in a financially troubled industry), and to policy change (for example, when IBM, a financially sound and employee-centric firm, simply chose to move away from the traditional defined-benefit pension plan).

But if we listen closely and honestly to *what clients tell us about their preferences*, the life-cycle investing point of view is compelling. Unlike what the Markowitz

mean-variance paradigm would predict, clients do not come to our offices asking for the biggest portfolio they can assemble before retirement. Instead, our clients typically describe personal retirement goals in words something like this: "I want to be able to maintain my standard of living for the rest of my life, to be protected from high health care costs, and with a little luck, to be able to help my children a bit, and to do some extra things in retirement, like travel. I don't want to go backward in my standard of living, and I'd like a chance of moving ahead. I am very concerned about financial safety."

These are exactly the personal preferences predicted—and addressed—by life-cycle investing.

### A Closer Look at Life-Cycle Investing

Let's take a closer look at the theory of life-cycle investing, and then return to the implications for our practices and for public policy.

In life-cycle investing, a person's total wealth is defined as the sum of their current financial wealth and the present value of their human capital—that is, what their labor will earn during their lifetime. There is a key assumption that, in general, people like to smooth consumption across their lifetimes and that they especially want to avoid big downward swings in their standard of living.

In this paradigm, personal finance thus becomes an exercise in transferring consumption *across time* and *across contingencies*, throughout the entire life cycle of the individual. For example, retirement savings shift consumption from high earning years to years when the individual is no longer in the workforce. In contrast, student loans and mortgages allow the individual to consume more in the present by borrowing against income expected in the future. Health insurance is a vehicle for transferring purchasing power across contingencies—that is, from "good" times of robust health to "bad" times when medical care is needed.

In this context, the challenge of public policy and financial innovation is to create the products and the appropriate markets for making these transfers reliably possible for the individual citizen.

But a big a-ha moment for the non-economist is to realize that a bedrock assumption in life-cycle investing is that there is no free lunch, and in particular that stock investments are not some kind of magic bullet that, if held for a sufficiently long time, will reliably create a secure retirement portfolio with minimal risk. Instead, retirement security results from a combination of saving, and insuring and hedging various risks, not by hoping to capture a higher standard of living by taking on large investment risk.

- *Hedging* means to sell the upside potential of an asset in return for downside price protection. The key to hedging strategies is to find a party whose risk preference is directly opposite yours.
- *Insuring* means to pay a known price to protect against the possibility of a larger loss on some risky asset but to still keep the upside potential for the investment return on that asset.

Economists are serious in saying that what consumers are about is transferring wealth across time and contingencies, not creating wealth across time and contingencies by investing in risky assets. The notion that stocks aren't risky if held for a long time is specifically rejected; stocks are risky investments no matter the holding period.

The easy proof? If stocks weren't risky in the long term, there would be no premium awarded to the long-term stock investor.<sup>12</sup> To be exact, the average annual return from stock investing does seem to converge over time to a positive number, and this convergence, in common understanding, has been taken to imply financial safety. But the range of possible end valuations for a particular stock portfolio widens dramatically over time and, importantly, includes the possibility of having a significant shortfall relative to the desired end portfolio

**Table 2: Proposed Ideas to Replace Popular Notions**

Popular Literature	Financial Economics
Saving is for the short run. Investing is for the long run.	Saving means income minus consumption; investing means selecting your portfolio of assets.
The only way to reduce risk is to diversify.	The simplest ways to reduce risk are to hedge, insure, or hold safe assets. A safe way to achieve a future consumption target is with CPI-linked bonds.
Stocks become safe in the long run due to "time diversification."	Stocks do not become safe even in the long run. If they did, they would not have a risk premium.
Zvi Bodie, presented at "The Future of Life-Cycle Saving & Investing," Boston University, October 2006.	

## A Step in the Right Direction

A step in the right direction, and an important bellwether for the financial planning profession, was a recent conference held at the Boston University School of Management in October 2006, sponsored by Boston University with co-sponsorship by the Federal Reserve Bank of Boston's Center for Behavioral Economics and the Research Foundation of the CFA Institute. The goal of the conference was to discuss what government, academia, and the private sector can do to address the looming challenge of protecting individual financial security in retirement. The major themes included the need for new personal finance products, appropriate government policies and regulations, safety valves, and improved public education.

Participants included economists from academia and the Federal Reserve as well as senior executives from the CFA Institute and the insurance, investment management, and banking industries, a high-level union representative, a few financial planners, a few members of the media, several financial entrepreneurs, and Nobel laureates Paul Samuelson and Robert Merton.

Discussion focused on how to make the individual saver safer and more successful. For more details, go to <http://smg.bu.edu/exec/elc/lifecycle>, where you can view a video of the dinner speeches by Professors Merton and Samuelson, and also read the academic papers supporting the conference discussions, many of which are referenced in this article. Visit the CFA Institute Web site at [http://www.cfawebcasts.org/cpe/what\\_pac.cfm?test\\_id=183](http://www.cfawebcasts.org/cpe/what_pac.cfm?test_id=183). Here you'll find videos of conference presentations and discussions.

value, which for the individual investor is a potential disaster.

From a life-cycle investing point of view, preparing for retirement thus requires investing savings in safe investments to the extent that is appropriate for one's personal circumstances, and insuring or otherwise addressing the risk of catastrophic losses, such as from poor health or challenging longevity. Then and only then does one consider how to capture the upside potential of volatile investments with an acceptable level of risk.

An additional tenet of life-cycle investing is that the source of labor income must inform investment choices in order to avoid having the investment portfolio move in a highly correlated manner with labor income. In this context, "safe" investments are investments such as structured standard-of-living contracts and inflation-indexed savings bonds, Treasury inflation-protected securities, and targeted savings accounts. (An example of a targeted savings account is a college savings plan where the promise to the investor is a pay-

ment of tuition instead of a payment of a specific dollar amount.)

A key insight of life-cycle investing is that there are safe investments, and further, that safe investments are appropriate as the base layer of personal wealth, an idea that can get lost in a culture where stock investing has become *de rigueur*.

Unfortunately, correct insights may be the needles in the haystacks of financial information currently available in the public domain. There are numerous examples of false ideas presented as correct information even on the Web sites of large and highly regarded institutions. Bodie identifies three notions ripe for purging from the popular literature, along with three replacement ideas from the discipline of financial economics that are, in contrast, worthy of wide promotion (see Table 2).

A vibrant market for the next generation of personal finance products will be necessary for the financial health of our clients, but the development of that market will depend on productive coordination among academia, industry, and the government. Although financial engineering is well developed at the institutional level, there is much work to be done to facilitate viable markets at the retail level for the next generation of personal finance products, such as structured standard-of-living contracts (see sidebar, "A Step in the Right Direction").

## Applications of Life-Cycle Investing

An example of an application of life-cycle investing is the notion that untapped home equity may be a luxury that we can no longer afford. Yet there clearly are problems in helping people access home equity in retirement. For instance, in the current market for reverse mortgages, there are high transaction costs and the potential for major adverse selection; unhealthy people do not apply for reverse mortgages. There is also, as economist Alicia Munnell points out, the risk of moral hazard—that is, the risk that people benefiting from reverse

mortgages will not continue to maintain their home as they did previously.<sup>13</sup> One observer has raised the idea of facilitating homeowners securitizing home equity, commenting that being able to sell a fractional interest in one's home in a well-developed market could be helpful, and that there are now several models for securitizing traditional assets. We have already seen the launching of new housing futures contracts on the CBOE (Chicago Board Options Exchange), a market that, once more fully developed, will offer intriguing possibilities for individual investors to take bets or hedge bets in the real estate sector.

In the planning community, an understandable initial reaction to life-cycle investing is concern that investing in safe investments instead of stocks would mean having to save at a much higher rate than most consumers consider reasonable. Interestingly, Professor Merton points out that one issue with defined-benefit pension plans is that they have historically been mispriced, and further that this situation was allowed to continue because a rising stock market in recent years made unrealistic return assumptions seem reasonable, thus masking the inherent risk in defined-benefit pension plans as traditionally structured.<sup>14</sup> It may be that the recent bull market in stocks has lulled both the planning community and the pension community into overestimating the reliability of stock appreciation to do the heavy lifting for long-term investors.

Now that employers more fully understand the true cost of providing pensions, many have opted out. Looking ahead, as pension-plan substitutes with appropriate pricing are introduced, there may be sticker shock for consumers when they are asked to buy the product. This implies a need for credible, market-based pricing and better education so that consumers can get used to the idea that securing purchasing power over several decades is not cheap. Perhaps in this process, consumers will discover that "less is more" if you are financially safe. In fact, economists have also documented that this is literally true:

Sharing longevity risk greatly reduces the amount a particular individual needs to save because people who die "early" subsidize those who enjoy greater-than-average longevity.

There are exciting product developments in the making as well as important public policy issues to address. As economist Francois Gadenne describes, whatever new products are developed, they must be scalable; the magnitude of this challenge is in the trillions, not billions, of dollars.<sup>15</sup>

Tax law and regulations also need updating to accommodate proposed new products. For example, as Anna Rappaport writes about in detail, the current mandatory withdrawal requirements for retirement plans are not designed to coordinate with the annuitized income streams suggested by life-cycle investing theory. Also, under current law, long-term care insurance is not an eligible retirement plan asset, yet a frequently proposed new investment product is an inflation-indexed annuity bundled with long-term care insurance.<sup>16</sup>

### Life-Cycle Implementation Problematic for Planners

In the planning world, few of our malpractice insurance policies cover investments in options or other derivative securities. Legally, the Prudent Investor Rule, which reflects mainly the modern portfolio theory paradigm, is now the official standard under trust law for fiduciaries.<sup>17</sup> Plus, there is little, if any, support in the financial planning literature or in our best practices for a life-cycle investing approach. These facts make it problematic for financial planners who are ready to move forward.

In the realm of public education, there is much work to be done on basic financial literacy with respect to an optimal savings rate and retirement plan choices, along with a need to get the general insights of life-cycle investing more widely distributed in our society.

As exemplified at "The Future of Life-

Cycle Saving & Investing," a conference held in October 2006 at Boston University (see sidebar on p. 52), there is a productive interdisciplinary conversation among economists and other financial services industry leaders about how to secure financial safety in retirement for individual consumers. But where is the voice from the financial planning community? Life-cycle investing is not explicitly incorporated into the financial planning literature or into our routine conversations with clients.

This gap is perhaps best explained with some historical perspective. In every field, there is a lag between a theoretical advance and the product innovation based on that advance. In our field, life-cycle investing theory was well laid out in the 1970s and the innovative products thoroughly developed for institutional use by the 1990s. The next step, which is underway, is to bring these advances to the retail market, with planners either at the center of the new wave or swept aside.<sup>18</sup>

For planners, the call to action includes

- Becoming conversant with the tenets and implications of life-cycle investing
- Preparing clients for this major change in perspective and contributing to accurate public education
- Helping to develop and critique new products, and through our general use of new products, provide our endorsement
- Contributing to the development of appropriate public policy, such as regarding retirement plan withdrawal rules
- Contributing to the trend of explicitly considering career asset management as a fundamental part of the financial planning process
- Developing skills to help clients decide when, how much, and at what rate to annuitize wealth, and becoming more knowledgeable about how to evaluate and monitor life-cycle investing products
- Updating our business models to incorporate annuitization and other life-cycle-based investment strategies

At first, these seem to be daunting challenges, especially the necessity to update what we have been telling our clients for decades—unless we remember to hearken closely to what our clients tell us in our direct conversations with them—that is, that their planning goals align exactly with what the theory of life-cycle investing predicts. My experience is that clients are intrigued and relieved when they hear me talk about the life-cycle investing point of view.

As life-cycle investing rolls our way, the planning community will be empowered to address the actual concerns of clients in a new and effective way. Let's join the new era and get in on the conversation.



## Endnotes

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2. See Robert C. Merton, "Lifetime Portfolio Selection by Dynamic Stochastic Programming: The Continuous Time Case," *Review of Economics and Statistics* (August 1969): 247–257, and Paul A. Samuelson, "Lifetime Portfolio Selection by Dynamic Stochastic Programming," *Review of Economics and Statistics* (August 1969): 239–246.
3. The theory of life-cycle investing discussed in this article should not be confused with the target-date or age-based life-cycle mutual funds that are a common investment choice in many 401(k) plans. These mutual funds are meant to provide one-stop shopping for individual investors mainly by having the allocation to stable investments rise steadily as the maturity date of the fund approaches. In contrast, this article references a whole body of knowledge in the financial economics literature known as life-cycle investing theory.
4. Zvi Bodie and Robert Merton, *Finance*, Prentice Hall, 2000, chapter 15: 384. In 1997, the Nobel Prize in economics was awarded to Robert Merton and Myron Scholes, with special posthumous mention of Fischer Black, for their work in specifying the mathematical formula for the pricing of options and other derivative securities.
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18. Paula H. Hogan, "Insurance Based Investment Products: Why Are People Talking About Them Now?" *Between the Issues*, October 2003.