

Chapter 5

Life-Cycle Funds

Luis M. Viceira

I am grateful to the Division of Research of the Harvard Business School for generous financial support. I am grateful to John Campbell, Jim Poterba, Annamaria Lusardi, and participants of the conference “Improving the Effectiveness of Financial Education and Saving Programs” for helpful comments and suggestions.

<A>Introduction<A>

The U.S. retirement system has experienced a substantial transformation in recent years. It has evolved from a system in which employees relied mainly on Social Security and professionally managed defined benefit (DB) pension plans sponsored by their employers to provide for their retirement to a system in which employees must rely on their own saving and investment decisions to fund their own retirement.¹ Defined contribution (DC) plan participants and IRA holders decide how much to contribute (up to a legally established maximum limit) to their plan, and how to invest their contributions and the contributions that their employer might make on their behalf. Thus the benefits they get at retirement depend on their own accumulation and investment decisions. DC plan sponsors are only responsible for the design of the plan and for its administration and record-keeping. Current regulations grant sponsors considerable freedom in their selection of the number and type of investment options available to participants. In practice, most plan sponsors have chosen to offer a menu of plain vanilla mutual funds plus company stock. Thus mutual funds have become the main retirement investment vehicle in the United States, and mutual fund companies the main managers of retirement assets.

In recent years plan sponsors have started including mutual funds geared toward offering “one-stop” solutions to retirement investment needs in their menu of investment options.² These

funds have originated in response to what numerous sponsors, mutual fund industry executives, and pension and investment experts consider a disappointing experience with the way in which many participants in DC plans and IRAs manage their plan investments. There is concern that many employees might not be making saving and investment decisions conducive to maximizing the probability of getting adequate retirement income.³

In particular, there is evidence that a large number of DC plan participants, particularly among those with lower levels of education, wealth, and income, show a considerable degree of inertia in their contribution and investing decisions. They tend to adopt the default contribution and investment option chosen by the plan sponsor, which is typically either no contribution or a small contribution that is entirely invested in a money market fund. Those who actively move away from the plan default investment option tend to adopt naïve diversification strategies, such as allocating equally among all the investment options in the plan, regardless of whether there are substantially more options in a particular asset class than in another. They also tend to invest heavily in company stock. Moreover, they fail to rebalance regularly.⁴

In response to this concern, plan sponsors have begun adopting mutual funds that aim at providing investors with one-stop solutions to their long-term asset allocation and portfolio rebalancing needs. These funds fall into two main categories: balanced, or “life-style” funds, which follow a “risk-based” asset allocation strategy and “life-cycle” funds, which follow an “age-based” asset allocation strategy. This chapter reviews modern theories of long-term investing, and explores their implications for the design of investment products that help investors save for retirement.

Risk-based investing and age-based investing are at odds with the asset allocation recommendations that emerge from traditional mean-variance analysis. However, recent

developments in the theory of asset allocation show that these strategies are optimal under realistic assumptions about investment opportunities and about the composition of investors' wealth. Based on these considerations, and the inertia that many investors exhibit in their portfolios, this chapter argues that properly designed life-cycle funds are better default investment choices than money market funds in DC pension plans.

However, the predictions of modern portfolio theory also suggest changes in the way that these funds are currently structured. Among other changes, this chapter argues that life-style and life-cycle funds should consider increasing substantially their allocation to inflation-indexed bonds at the expense of their current allocations to long-term nominal bonds, which are exposed to considerable inflation risk. Inflation-indexed bonds are also safer investment choices than money market funds for plan participants, because money market funds, while safe at short horizons, can be highly risky at long horizons when investors face real interest rate (or reinvestment) risk.

This chapter also argues for the creation of industry-specific or company-specific life-cycle funds. These funds can help solve some of the design shortcomings of the current generation of life-cycle funds in a cost-effective way. The creation of "conservative," "moderate," and "aggressive" life-cycle funds can also help investors choose the equity profile that best fits their appetite for risk. This chapter also suggests that investors who expect to receive Social Security benefits and pension income after retirement should choose a target retirement date for their funds based on their life-expectancy, not their expected retirement date.

Finally, this chapter argues that, while life-cycle funds are better default investment choices than money market funds in DC plans, they should not be the only choice available to plan participants. For example, life-cycle funds can be a tax inefficient way of implementing an

“age-based” investment strategy for plan participants who have the ability to save outside the plan. These employees might want to build their own tax-efficient life-cycle investing strategy. Similarly, employees who feel financially educated enough might want to build an asset allocation strategy specifically designed for their own risk profile and retirement spending goals.

<A>Life-Style Funds and Life-Cycle Funds<A>

Balanced or life-style funds have a long tradition in the mutual fund industry, while life-cycle funds are relatively new to the industry. Life-style funds are mutual funds built on the idea of “risk-based investing,” or the notion that the fraction of savings allocated to stocks should be a function of investors’ risk tolerance and independent of their investment horizon. Life-cycle funds are a variant of life-style funds built on the idea of “age-based investing,” or the notion that investors should allocate a larger share of their long-term savings to stocks when they are young and have long retirement horizons, and decrease this allocation as they approach retirement.

Life-style funds automatically rebalance their holdings, typically a portfolio of underlying funds representing different asset classes and investment styles, so as to keep a constant asset target mix over time. These funds provide investors with diversified portfolios whose risk exposure does not change over time. For example, Vanguard Balanced Index Fund tracks the investment performance of a portfolio 60 percent invested in the U.S. stock market and 40 percent in the U.S. bond market.⁵ Mutual fund companies typically offer several of these funds, and use words such as “aggressive,” “moderate,” or “conservative” in the fund name to indicate the fund’s tilt toward equities.

Similar to balanced funds, life-cycle funds automatically rebalance the investments in the underlying funds to keep the overall portfolio composition of the fund in line with a pre-

specified asset target mix. Unlike balanced funds, however, life-cycle funds do not keep their target mix constant over time; instead, they change their target mix according to a predefined “rolldown” schedule until they reach a date called the target date or target maturity date of the fund. This rolldown schedule becomes more conservative over time, in the sense that it tilts the target mix away from equities and toward bonds and cash. After the target date, these life-cycle funds are typically folded into a life-style fund that keeps its target asset allocation constant. Table 5.1, Figure 5.1, Table 5.2 and Figure 5.2 show the life-cycle fund offerings, including asset allocation glide paths and returns, of the two largest life-cycle fund families ranked by assets managed in 2006, Fidelity’s Freedom Funds and Vanguard’s Target Retirement Funds , respectively.

[Insert Table 5.1, Table 5.2, Figure 5.1 and Figure 5.2 here]

Life-cycle mutual funds are one of the fastest growing segments in the mutual fund industry. Assets under management in these funds were about \$120 billion at year-end 2006, from about \$1 billion in 1996, when Fidelity, the industry leader in this segment, launched its own version of these funds. This growth has accelerated in recent years with inflows of \$15 billion in 2004, from less than \$5 billion in 2001 and 2002.

This growth has taken place mostly through both individual retirement accounts and DC plans, as sponsors of DC plans have added these funds to their plan offerings. In the future, industry experts expect numerous plans to adopt these funds as the plan default investment option as a result of the enactment of the Pension Protection Act of 2006, which gives sponsors more flexibility in guiding participants in their fund selection.

The main characteristic of life-style funds is that they change the stock exposure of the fund as a function of investors’ risk tolerance. Life-cycle funds reduce the stock exposure of the

fund as their target maturity date approaches. Both approaches to asset allocation are in line with the advice that financial planners traditionally give to their clients and with conventional investing wisdom.

A different question, however, is whether these allocation strategies have any fundamental scientific basis. This is an important question given the relevance of asset allocation decisions to investors' welfare. Poor investment and savings decisions can seriously undermine the long-term welfare and wealth accumulation of investors. Thus, providing investors with sound portfolio advice is of first-order importance. What does academic finance have to say about the investment decisions of long-term investors? What are the prescriptions of the theory of long-term investing for the design of life-style and life-cycle funds? I explore these questions in the remaining sections of this chapter.

<A>Asset Allocation in a Mean-Variance Framework<A>

The analysis of portfolio decisions has a great academic tradition in finance. In fact, modern finance is often thought to have originated with the mean-variance analysis that Harry Markowitz developed more than fifty years ago.⁶ Markowitz showed how investors should pick assets if they care only about the mean and variance—or equivalently, the mean and standard deviation—of portfolio returns over a single period.

Mean-variance analysis has transcended its academic origins to become the basic paradigm guiding portfolio advice. Mean-variance usefully emphasizes portfolio diversification, the principle that investors should eliminate exposure to risk that is not rewarded. Mean-variance analysis, however, also makes asset allocation recommendations which are often at odds with conventional wisdom.

One of the most famous results in mean-variance analysis is the mutual fund theorem of portfolio choice first formulated by the late James Tobin.⁷ According to this theorem, all investors should combine cash with a single portfolio or “mutual fund” of risky assets. Consider the basic problem of allocating a portfolio amongst three broad asset classes: stocks, long-term bonds (“bonds”), and short-term bonds or money market funds (“cash”). The mutual fund theorem directs all investors, conservative or aggressive, to hold the *same* portfolio of stocks and bonds, mixing the portfolio with more or less cash depending on the investor’s tolerance to risk.

This portfolio advice is at odds with conventional investing wisdom, as well as the way that life-style funds allocate assets between “aggressive” and “conservative” funds. In practice, both conservative investors and conservative life-style funds favor bonds relative to equities, so the ratio of bonds to stocks increases as portfolios become more conservative. In the previous example, the more conservative investor might be advised to hold a portfolio consisting of 40 percent equities, 40 percent bonds, and 20 percent cash, with a 2:1 ratio of stocks to bonds.

Another implication of mean-variance analysis is that it directs investors to maintain the same asset allocation regardless of their age or investment horizon. This advice is at odds with the advice that financial planners traditionally give their clients and with the asset allocation patterns embedded in life-cycle funds, all of which suggest that the allocation to equities should be directly related to investment horizon.

Thus traditional mean-variance analysis does not seem to provide scientific support for the “risk-based investing” approach and the “horizon-based investing” approach to asset allocation that characterize life-style funds and life-cycle funds, respectively. However, the asset allocation advice that emerges from mean-variance analysis is based on two critical assumptions. First, mean-variance analysis assumes that investors live in a parsimonious world of constant risk

and return. In such a world, it is optimal for long-term investors to act as short-term investors, ignoring the long-term.⁸ Second, mean-variance analysis treats financial wealth independent of income.

For decades, the assumption of constant investment opportunities constituted a good approximation of reality to academics and practitioners alike. But in recent years, both academic research and industry research has shown through careful empirical analysis that changes in investment opportunities are quantitatively important. Long-term investors typically receive a stream of income and use it, along with financial wealth, to support their standard of living. In recent years, academic finance has explored the impact of these considerations on long-horizon investing, building on the early theoretical insights on dynamic portfolio choice of Robert Merton and Paul Samuelson in the late 1960s.⁹ In particular, it has shown that they provide a *qualified* support for “risk-based investing” and “age-based investing.” This issue is explored next in greater detail.

<A>The Case for “Risk-based Investing”: Interest Rate Risk and the Optimal Bond Allocation of Long-term Investors<A>

A traditional idea in investment theory and practice is that cash (e.g., short-term default-free bonds or bills) is the safe asset for all investors. Traditional mean-variance analysis treats cash as the riskless asset, and considers bonds as another risky asset like stocks. Bonds are valued only for their potential contribution to the expected short-run excess return, relative to risk, of a diversified risky portfolio.

This idea is rooted in the perception that real interest rates are constant. In reality, real interest rates change over time, and future real interest rates are far from certain. In such

circumstances, cash is safe for short-term investors, provided that short-term inflation risk is small, but it is not safe for long-term investors. If future real interest rates eventually decline, these investors need to worry about the impact on their long-term welfare of constantly reinvesting wealth in short-term instruments.

A strategy of constantly reinvesting wealth in short-term bonds will preserve investors' initial wealth, but not necessarily their ability to spend out of this wealth. If real interest rates decline, investors will have to either reduce their spending to accommodate this reduction in the yield on their wealth, or deplete part of the principal to maintain their spending, with the subsequent impact that this reduction in wealth might have on their future well-being.

An article in *The Wall Street Journal* on July 7, 2003, provides a vivid example of the importance of reinvestment risk for long-term investors. The article recounts the stories of several people in Florida who retired during the last twenty years and followed the conventional strategy of continuously investing their retirement assets in certificates of deposit and other short-term fixed-income instruments and living off the interest income produced by these investments. As nominal interest rates fell faster than the prices of services and goods they consume—that is, as real interest rates declined—during the 1980s, 1990s and early 2000s, these retirees were forced to substantially reduce their standards of living. The title of the article says it all, “As Fed Cuts Rates, Retirees Are Forced to Pinch Pennies—With Interest Income Down, Seniors in Florida Complex Are Facing Tough Choices—A \$1.63 Splurge at Burger King.”

In contrast to a strategy of constantly reinvesting wealth in short-term bonds, a strategy of investing in long-term bonds will protect spending, since these bonds will increase in value as real interest rates decline, thus providing the extra cushion investors need to maintain their spending plans without depleting the initial principal.

This analysis, while enlightening and helpful, is still incomplete. In practice, the coupons and principal payments of long-term bonds such as Treasury bonds are typically fixed in nominal terms. This means that the value of these bonds is also affected by an additional factor: inflation. If inflation is volatile, the ability of long-term bonds to protect spending plans on an inflation-adjusted basis can be seriously undermined. Larger than expected inflation rates will erode the purchasing power of these bonds, even if real interest rates do not move at all. By contrast, inflation-indexed bonds, which the U.S. Treasury started issuing in 1997 under the denomination of TIPS (Treasury Inflation Protected Securities), are immune to the potentially devastating effects of unexpected inflation. Thus investors need to be aware that regular Treasury bonds are safe investments only when inflation risk is low.

Establishing the extent to which real interest rate risk and inflation risk are important is of key importance to investors, because it determines which financial instruments are safest at long horizons. In a study of portfolio selection with inflation risk and real interest risk, Campbell and Viceira (2001) find that real interest rates vary enough over time to make cash a risky investment at long horizons, and that, except for the Volcker-Greenspan period of the last twenty years, inflation risk is large enough to make long-term Treasury bonds poor substitutes for inflation-linked TIPS.¹⁰ They show that, in an environment of changing real and nominal interest rates, long-term investors should optimally allocate a larger fraction of their wealth to long-term inflation-indexed bonds as they become more conservative. The ratio of bonds to stocks increases with risk aversion and in the limit when investors' risk tolerance approaches zero, long-term investors allocate all their financial wealth to long-term inflation indexed bonds, not cash.

Extremely conservative long-term investors prefer long-term inflation-indexed bonds to cash because, while T-bills help investors preserve capital, they do not necessarily preserve long-term standards of living. Long-term inflation-indexed bonds, not cash instruments, are the riskless asset for conservative investors who care about financing their long-term spending plans or liabilities.

The analysis in Campbell and Viceira has significant implications for the design of investment vehicles for long-term investors. First, this analysis provides support for the idea of “risk-based investing,” i.e., the idea that the portfolio share of bonds should be larger in conservative portfolios than in aggressive portfolios. However, this support is qualified. These bonds should be inflation-indexed bonds (or TIPS). Nominal bonds play an important role in conservative portfolios only when inflation risk is low, and they are close substitutes of inflation-indexed bonds.

Table 5.3, which reproduces selected columns from Table 3.3 in Campbell and Viceira (2002), illustrates this result. The table shows the optimal percentage allocation to stocks, bonds, and cash of investors with different degrees of risk aversion. The left columns in the table consider a problem in which investors can choose between cash, stocks, and inflation-indexed long-term bonds. The right columns consider a problem in which inflation-indexed bonds are not available, and instead investors can choose between cash, stocks, and nominal long-term bonds. Panel A shows optimal allocations to each asset class implied by the dynamics of real interest rates and inflation in the post–World War II period, which was characterized by significant inflation risk. Panel B shows the allocations implied by the dynamics of real interest rates during the last two decades of the twentieth century, which was characterized by much lower inflation risk than the rest of the postwar period.¹¹

[Insert Table 5.3 here]

The first row in each panel shows the optimal allocations of investors with the coefficient of relative risk aversion equal to one. These are aggressive investors who value bonds only for their short-run properties (i.e., the contribution they make to their portfolio expected excess return and short-run volatility) and not for their long-term properties. As we move down the columns, the rows show the optimal allocations for increasingly conservative long-term investors.

Table 5.3 shows that the portfolio share of inflation-indexed bonds relative to the portfolio share of stocks increases with risk aversion, and is basically 100 percent for investors with extremely high risk aversion coefficients. By contrast, the allocation to nominal bonds in Panel A is very small for all investors, including those who are extremely conservative. These investors prefer to move away from equities and into cash, because nominal bonds in this period are subject to considerable inflation risk and in practice are poorer substitutes for inflation-indexed bonds than cash itself. This picture changes completely in Panel B, where low inflation risk makes nominal bonds close substitutes of inflation-indexed bonds.

Second, the mutual fund industry has designed life-cycle funds so that they are folded into a balanced “retirement fund” at or shortly after their target maturity date. These balanced funds tend to have very small allocations to equities and inflation-indexed bonds and large allocations to nominal bonds and cash (See Tables 5.1 and 5.2). The allocations shown in Table 5.1 suggest that these retirement funds and in general all balanced funds except the most conservative ones should contain a considerable allocation to equities. They also suggest that balanced funds, particularly conservative balanced funds, should contain significant allocations

to inflation-indexed bonds. Substitution of nominal bonds for inflation-indexed bonds makes an implicit bet that inflation risk will stay low in the future, which might or might not happen.

Third, this analysis suggests that the long-standing practice of sponsors of defined-contribution pension plans choosing a money-market fund as the default option for plan participants might not be appropriate if the goal is to choose a safe investment. With that goal, the choice should instead be a portfolio of long-term bonds, preferably inflation-indexed. Of course, plan sponsors might be simply responding to a legal and regulatory environment that is mistakenly focused on preservation of initial principal as the “safe choice.” If so, this analysis suggests that there should be a discussion of what the regulatory concept of a safe long-term investment should be.

Fourth, this analysis also suggests that the issuance of inflation-indexed bonds by the Treasury has a significant impact on welfare, as it provides long-term investors with a truly riskless long-term investment vehicle.

<A>The Case for “Age-based Investing”<A>

Mean Reversion in Stock Returns

The standard theory of asset allocation treats equities as a risky asset class whose high historical average returns represent compensation for commensurately high risk. In recent years, however, it has become commonplace to argue that equities are actually relatively safe assets for investors who are able to hold them for the long term. This view is based on evidence that stock returns are less volatile when they are measured over long holding periods.¹² As illustrated in Figure 5.3, the annualized volatility of real (or inflation-adjusted) U.S. stock returns appears to

decline with holding horizon, from about 16 percent per annum at a one-year horizon, to about 8 percent per annum at horizons of twenty-five years or longer.¹³ Similarly, the range of U.S. stock returns experienced by investors since 1926 changes depending on the holding horizon, with short horizons exhibiting a much wider spread than long horizons, as shown in Figure 5.4. Similar patterns are visible in some international markets.¹⁴

[Insert Figure 5.3 and Figure 5.4 here]

This evidence has been used to promote a strategy of buying and holding equities for the long-term, and to support the horizon-based allocations of life-cycle funds.¹⁵ Indeed, several studies show that these findings imply that buy-and-hold long-term investors should hold more equities in their portfolios than buy-and-hold short-term investors.¹⁶

A different question, however, is whether a strategy of aggressively buying and holding stocks for the long-term, or the deterministic rebalancing strategy implemented in life-cycle funds are desirable long-run investment strategies if stock returns behave the way the data suggest. The key to answering this question resides in understanding what makes stock market risk decrease significantly at long horizons.

In a world of time-invariant risk and return, risk per period (measured as the annualized variance of holding period returns) is constant across all investment horizons. Thus, if expected returns were constant, the line shown in Figure 5.3 would be horizontal, not decreasing.¹⁷ Therefore, the evidence for reduced risk of stocks at long horizons is inconsistent with constant expected returns. In fact, it is indirect evidence for predictable variation in stock returns.

Empirically, times of unusually high stock prices relative to dividends or earnings appear to be followed by periods of low average stock returns, and conversely, times of low stock prices relative to dividends or earnings tend to be followed by periods of high average stock returns.

Figure 5.5 illustrates this evidence. It plots ten-year real returns on the S&P 500 when stocks are purchased at different initial price-to-earnings multiples and dividend-to-price ratios.¹⁸ This figure is constructed from Robert Shiller's annual dataset for the period 1871–2004.

[Insert Figure 5.5 here]

Figure 5.5 shows that when stock market valuations relative to earnings or dividends were in their lowest quintile in this period, real returns over the following ten years were about 10–11 percent per annum on average. This average return was more than twice as large as the average return in ten-year periods following times in which stocks relative to earnings or dividends were in their highest quintile. Thus stock returns appear to revert toward a long-run average or mean, and stocks are said to be mean-reverting.

But, if returns are predictable, then why would long-term investors want to pursue a buy-and-hold investment strategy, or a strategy of mechanically rebalancing away from equities as their investment horizon shortens? Should they not instead change their allocation to stocks as a function of prevailing market conditions? For example, they might want to decrease their allocation to stocks when expected future stock returns are low (e.g., at times when stock prices are high relative to earnings or dividends), and conversely increase it when expected future stock returns are high (e.g., when stock prices are low relative to earnings or dividends).

Several academic studies have addressed this question in depth using formal models of long-term portfolio choice under time-varying expected stock returns.¹⁹ These studies show that long-horizon investors should indeed vary their allocation to stocks in response to changes in expected stock returns. However, these changes are only gradual, not the type of volatile high-frequency trading that is often recommended by “tactical asset allocation” programs. The reason for this gradual approach is that empirically expected stock returns seem to change slowly. The

variables that proxy for expected returns, such as dividend yields, smoothed price-earnings ratios, and interest rates, are highly persistent, slow-moving variables.

This research also finds that, at the same time, it is optimal for long-term investors to introduce a strategic tilt toward equities in their portfolios, even as they vary their actual allocation at shorter horizons. This strategic tilt reflects a positive intertemporal hedging demand for stocks and it is relatively insensitive to changes in expected returns. If stocks mean-revert, realized stock returns are high at times of low expected future stock returns. It is in this sense that stocks provide a good hedge against a deterioration in their own expected future return, and are relatively safer assets for long-term investors.

Stock return predictability also affects the composition of equity portfolio. Jurek and Viceira (2006) show that at times when expected aggregate stock returns are low, growth stocks—stocks with high prices relative to earnings or dividends—tend to deliver higher realized returns than value stocks—stocks with low prices relative to earnings or dividends—do.²⁰ This makes growth stocks less risky than value stocks from the perspective of long-horizon investors, since they provide a better hedge against market downturns. Thus the strategic tilt toward equities in long-horizon portfolios should be itself biased toward growth stocks.

In sum this research suggests that long-term equity investors should invest more on average in equities than their short-horizon counterparts, but they should also consider periodic revisions of this allocation as market conditions change. It is logically inconsistent to count on reduced long-term risk while ignoring the variation in returns that produces it. This market-sensitive allocation policy is very different from the asset allocation policy of life-cycle funds, whose target mix moves mechanically away from stocks as an inverse function of investment

horizon, regardless of market conditions. Thus mean-reversion arguments provide, if anything, only a partial justification for the rolldown schedule characteristic of life-cycle funds.

The idea of age-based investing focused on mean-reversion is further challenged by the ongoing debate in empirical finance about the robustness of the statistical evidence on stock return predictability. Some research disputes this evidence,²¹ while other claims that the observed time series variability in dividend yields and the lack of empirical evidence that aggregate dividend growth is predictable are consistent with stock return predictability.²²

A body of research has explored the implications of uncertainty about the existence of mean-reversion in stock returns on asset allocation.²³ This research finds that this uncertainty should make investors more cautious when changing their equity allocation in response to changes in market conditions than investors who take the estimated stock return processes at face value. However, they are still willing to engage in market dependent asset allocation strategies. This uncertainty also dampens, but does not eliminate, the long-term strategic tilt toward equities induced by mean-reversion. Of course, the magnitude of these effects depends on investors' initial uncertainty. In a model with fixed underlying parameters, the learning effect is transitional and will eventually disappear as investors become more and more confident about the true data-generating process.

Human Capital and Asset Allocation

I have noted that mean-variance analysis ignores that investors have additional sources of wealth besides their financial wealth. One of these sources, arguably the most important for most individual investors, is human capital, or the present discounted value of their expected future labor earnings.

Unlike other types of capital, human capital is not tradable. Investors cannot sell claims against their future labor earnings, but they can extract value from their human capital through the earnings it produces over time, which they can then use either to finance their current spending, or to save and thus increase their financial wealth.

Just because human capital is not tradable does not mean that investors should ignore it when deciding how to invest their financial wealth (or savings). In fact, Bodie, Merton, and Samuelson (1991) have shown that human capital considerations should lead investors to change the target asset allocation for their financial portfolios as they age. This is because as investors age, their human capital gets depleted as it is transformed into consumption and savings.

The relation between human capital and asset allocation is easiest to see if we consider an investor who knows his income in advance with perfect certainty. For this investor, human capital is equivalent to an implicit investment in bonds. When the investor is young and has many years of earning labor income ahead of him, but little wealth saved, human capital represents a large share of his total wealth. The investor should then tilt his financial portfolio toward risky assets to offset the large bond position he already holds through his human capital.

As the investor ages, the value of his human wealth declines (he has fewer years left to earn labor income) while his financial wealth grows. Thus the bond investment represented by his human wealth becomes less important relative to his total wealth, and the investor will want to attenuate the tilt toward risky assets in his financial portfolio.

Figure 5.6 illustrates this principle using a stylized example. This figure plots the asset allocation of a life-cycle investor along the expected path of labor earnings and expected returns during the investor's working years. The figure is built under the following assumptions: First, it assumes that the investor wishes to hold a 60-40 percent stock-bond portfolio. Second, the

investor works for thirty-five years. He starts with an initial salary of \$60,000 per annum which grows at a real (or inflation-adjusted) rate of 4 percent per annum. Third, the investor starts with initial financial wealth of \$75,000. This wealth grows through the returns he obtains on his investments, and through the savings he adds every year. The figure assumes that he saves 15 percent of his salary every year and that equities return 6 percent per annum on average and bonds 2.3 percent per annum in real terms. The real riskless rate is also 2.3 percent.²⁴

[Insert Figure 5.6 here]

Under these assumptions, when the investor still has thirty-five years left until retirement, his human capital is worth \$2.864 million. This is the present value of all his future earnings discounted at the riskless rate of 2.3 percent. Since he also has \$75,000 in savings, his total wealth equals \$2.939 million. Given his target mix, this investor would like to hold \$1.764 million in stocks, and \$1.175 in bonds. But he has already an implicit investment in bonds through his human capital worth \$2.864 million, which is well above his target allocation. Thus this investor will opt to invest the entirety of his financial wealth (\$75,000) in stocks in an effort to get as close as possible to his 60 percent target allocation to stocks.

Interestingly, this investor will appear to an outside observer as a very aggressive investor because he allocates 100 percent of his financial wealth to stocks. In practice, however, his overall wealth portfolio is actually heavily tilted toward bonds: 97.4 percent of his total wealth is invested in bond-like wealth.

As he grows older and approaches retirement, the value of his human capital declines, and his financial wealth grows. However, the ratio of financial wealth to human capital does not grow fast enough for the investor's desired bond holdings to be larger than the value of his human capital until year thirty-one. At that point his financial wealth has grown to \$1.6 million,

and his human capital is still worth \$1.022 million. Thus his total wealth is \$2.6022 million, of which he would like to hold \$1.050 million in bonds. Since his bond-like human wealth is worth less than his desired allocation to bonds, at this point he starts investing part of his financial wealth in bonds, and moves away from stocks. The investor starts investing 2 percent of his financial wealth in bonds, which grows to 34 percent in the last year of his working life.

Figure 5.6 shows a path for asset allocation in which the share of financial wealth allocated to equities declines as the investor approaches retirement. Thus human capital considerations provide support for “age-based investing.” However, there are some important caveats to this conclusion.

First, Figure 5.6 shows an asset allocation path which is much more aggressive than the asset allocation path typical of life-cycle funds (see Tables 5.1 and 5.2). Despite the fact that the investor aims at a relatively conservative target allocation for his total wealth (60 percent stocks-40 percent bonds), the resulting asset allocation path for financial wealth is fully invested in stocks for thirty years of his thirty-five years of his retirement horizon. In the remaining five years, the allocation to equities is always above 65 percent. This suggests that the asset allocation path of life-cycle funds is perhaps too conservative.

Of course, one could argue that this example is unrealistic. In practice, future labor income is uncertain for most investors, which makes human wealth a risky non-tradable asset. This might make investors wish to invest their financial wealth more conservatively than in the case with perfectly safe human capital. However, this conclusion does not hold for plausible representations of labor income risk.

In a study of optimal asset allocation with labor income uncertainty, Viceira (2001) finds that investors with risky labor income should still tilt their portfolios toward stocks when they

are young, provided that labor earnings are not too volatile and that they are uncorrelated with the stock market.²⁵ For these investors, the risk in their human capital is largely idiosyncratic and as such is more similar to an investment in bonds than to an investment in stocks. The resulting asset allocations for investors with typical earnings volatility (around 10 percent per annum) and low correlation with stock returns are still more aggressive than the asset allocations typical of life-cycle funds. Labor earnings must be highly volatile to significantly reduce the investors' willingness to hold equities in their portfolios.

Second, while idiosyncratic, risky labor income might ameliorate the pronounced tilt toward stocks that riskless labor income suggests, there are other considerations which actually work in the opposite direction. Most investors receive Social Security benefits and many receive other pension benefits when they retire. Pension income is also bond-like, and should make investors even more willing to tilt their portfolios toward equities.²⁶

Another consideration is the ability of many working investors to influence the value of their human wealth by varying how hard they work. The ability to vary work effort allows individuals to hold riskier portfolios because they can work harder if they need extra labor income to compensate for losses in their financial portfolios. In their study, Bodie, Merton, and Samuelson (1991) emphasize that the tilt toward risky financial investments with riskless labor income is strengthened if investors have the ability to adjust their labor supply. Chan and Viceira (2000) have shown that this result carries over when labor income is idiosyncratically risky.

Third, recent research on portfolio choice with risky labor income shows that realistic calibration of labor earnings profiles lead to asset allocation paths in which stock portfolio shares are not necessarily monotonically decreasing with retirement horizon. Cocco, Gomes, and Maenhout (2005) show empirical evidence which, unlike the stylized example I have just

presented, assumes that earnings grow at a steady rate over the working life of the investor, the earnings profile of a typical working investor exhibits a hump shape. Labor earnings grow at increasingly higher rates until employees are about 45 years old, at which point they stop growing or even decrease until they retire.

They next note that this also implies a hump shape for the value of human wealth, which in turn implies a hump shape for the optimal asset allocation path for equities as investors age. That is, investors should hold portfolios which are more conservative early in their working lives, become more aggressive as they approach middle-age, and then become increasingly more conservative. However, they find that the share of human capital on total wealth at young ages for a typical working investor is so large relative to financial wealth that these investors still want to hold almost if not all of their financial wealth in equities. Thus their findings suggest that life-cycle funds should perhaps exhibit a slightly hump shaped equity allocation path instead of a monotonically declining path.

Fourth, asset allocation is highly sensitive to the correlation of labor earnings with stock returns. In his study of optimal asset allocation with labor income uncertainty Viceira (2001) shows that small correlations significantly reduce the portfolio tilt towards equities in financial portfolios, and large correlations might even reverse this tilt, and make younger investors less willing to hold equities in their financial portfolios than older investors. In fact, Benzoni, Collin-Dufresne, and Goldstein (forthcoming) argue that aggregate labor income and dividends exhibit a large, positive long-run correlation, even though they exhibit a low short-term correlation. This positive long-run correlation implies a hump-shaped allocation to stocks over the working life of the investor.

This is so because in this case human capital is more stock-like than bond-like, and young investors should compensate by tilting their financial portfolios toward bonds, and away from stocks. In the extreme case where labor income is perfectly positively correlated with the return on stocks, human wealth is in fact an implicit investment in stocks. Thus life-cycle funds will not be appropriate for investors whose labor earnings are highly correlated with the stock market.

Correlation considerations are important in other aspects of the design of DC plans. Current regulations allow corporate sponsors to include company stock as part of the menu of investment options available to plan participants. Arguably, employees' labor income is likely to be highly correlated with the fortunes of the company they work for. They should not only avoid holding an undiversified position in their employer's stock, but they should actually underweight the company stock relative to its weight in an index fund. If employees fail to understand this point, or mistakenly think they have superior information about company stock, they might allocate too large a fraction of their retirement savings to company stock. The recent bankruptcy of Enron and the subsequent negative effect on employee retirement benefits has made some investors painfully aware of the risks of investing in company stock.

Finally, it is important to note that while all these models support the notion that retirement horizon matters for asset allocation, they do not prescribe a unique asset allocation path for all investors with identical human capital characteristics. This asset allocation path is a function of both human capital and the investor's risk tolerance. Thus they imply that life-cycle funds should be both "age-based" and "risk-based." These studies also ignore important factors that affect the ability of individuals to work in the future such as health risk and mortality risk. A recent study by Edwards (2005) suggests that health risk considerations effectively increase the risk aversion of investors.

<A>The Design of Life-cycle Funds<A>

General Considerations

The previous two sections of this discussion have explored what modern financial economics has to say about long-run asset allocation strategies and its implications for the design of life-cycle funds and the life-style or balanced funds into which these funds fold once they reach their target maturity date. In general, the findings of modern financial economics provide support for a notion of age-based investing where age (or retirement horizon) is a proxy for human capital, but they provide weaker support for a notion of age-based investing that builds on the idea of mean-reversion in stock returns.

Research on long-run investing suggests that life-cycle funds should adopt an asset allocation path heavily tilted toward equities until they are fairly close to their target date. This asset allocation path is based on the typical labor earnings profile, which exhibits low volatility and low correlation with stock returns, and is more aggressive than the asset allocation path of most life-cycle funds currently available to investors. However, employees whose earnings are highly volatile or exhibit significant correlation with stock returns should adopt life-cycle investment strategies with a much less pronounced tilt towards equities.

This research also suggests that the retirement horizon of the investor (a proxy for his human capital) should not be the only variable that determines the asset allocation path of life-cycle funds. Market conditions should induce low-frequency adjustments to the path, as expected returns change over time.

Risk tolerance should also influence this allocation path. To the extent that investors systematically differ in their risk tolerance, it makes sense to consider creating “aggressive,” “moderate,” and “conservative” life-cycle funds instead of offering a single life-cycle fund per target date. For example, Poterba et al. (2005) have conducted simulations suggesting that the asset allocation of a typical life-cycle fund can produce lower expected utility (or welfare) than a 100 percent stock allocation for aggressive investors.

It is also important to give consideration in life-cycle fund design to the term structure of target maturity dates. Long maturity dates that match current life-expectancy projections instead of expected retirement dates should probably be considered. Investors who expect to receive pension income from other sources, such as Social Security or traditional DB pension plans, should probably choose life-cycle funds with target dates well beyond their expected retirement date, to account for the fact that their pension income represents a bond-like investment just as their labor earnings do. Of course, investors with no significant pension income should choose target dates that match their expected retirement date.

The findings of modern financial economics also have clear suggestions about the assets that should be included in these funds. First, modern financial economics shows that long-term inflation-indexed bonds, not cash, are the safest asset for long-term investors. Long-term nominal bonds are subject to inflation risk and are safe only when this risk is low; otherwise they are risky assets and poor substitutes for inflation-indexed bonds. This strongly suggests that long-term inflation bonds should play an important role in these funds, particularly conservative funds, while cash should probably not play a role. In fact, the simulations conducted in the study of Poterba et al. (2005) show that all investors would consistently experience a gain in welfare if they adopted life-cycle funds, which replace nominal bonds with TIPS. This is in sharp contrast

with the allocations of most, if not all, of the life-cycle funds available to investors, where inflation-indexed bonds play only a marginal role.

Second, the equity allocations of life-cycle funds and life-style funds are typically heavily biased toward U.S. stocks. They typically define the “stock market” as the U.S. stock market, and include only small allocations to international stocks, which are typically defined as being riskier than U.S. stocks. However, it is hard to see why the stock of GM or Ford is inherently safer than the stock of Toyota or Honda. The empirical evidence available suggests that a well-diversified portfolio of equities should include a healthy allocation to international equities.²⁷ In a recent study, Campbell, Serfaty-de Medeiros, and Viceira (2007) show evidence that such a portfolio should have its currency exposure fully hedged, except for the European and Swiss component of the portfolio, which should be left unhedged.

Third, the equity allocations of life-cycle funds should probably be tilted toward growth stocks and away from value stocks at long-horizons. This tilt should decrease as the funds approach their target maturity date. Growth stocks appear to be safer than value stocks at long-horizons.²⁸ This tilt should be more pronounced for moderate and conservative life-cycle funds.

These design considerations for life-cycle funds are all based on three premises: first, that investors are homogeneous in their human capital characteristics and in their risk tolerance; second, that they use these funds as their only long-term saving vehicle; and third, that tax considerations are irrelevant. Under those premises, one single life-cycle fund per retirement horizon is enough. I explore next the implications of relaxing these premises.

Heterogeneity in Human Capital Characteristics and Risk Tolerance

Life cycle funds are designed to provide investors with a one-stop solution to their investment needs. However, arguably there is considerable heterogeneity among investors with respect to their risk tolerance and the characteristics of their human capital. Factors such as health risk, expected longevity, family composition, job changes, and others are individual-specific and might change over the lifetime of an individual. These considerations would suggest that the “one-size-fits-all” approach of life-cycle funds is inadequate, and that individually managed accounts would be more appropriate than a single asset-allocation fund, since they can take into account these individual-specific characteristics when making asset allocation recommendations.

It is important to note that this individualized approach is different from the “interior decorator” approach to investing popular among some financial advisors, who build concentrated, investor-tailored stock portfolios for their clients instead of well-diversified stock portfolios, thus exposing them to considerable idiosyncratic risk. Here the goal is to use asset allocation to help investors hedge systematic risk through asset allocation risk. Investors should still hold a well-diversified portfolio of equities.²⁹

Ultimately, separate managed accounts might be the right approach in an ideal world. In practice, however, managing separate accounts is an expensive process whose cost is driven by the need of intensive human intervention. Currently, separate managed accounts are cost effective only at sizable account balances. Thus in considering adopting an individual approach, investors need to weigh the cost of these accounts against the cost of adopting a fund whose asset allocation path might not fit exactly their human capital characteristics and risk tolerance. Of course, in addition to the cost of deviating from what’s optimal for them in an ideal world,

investors also need to consider the fees on life-cycle funds. However, most mutual fund companies do not charge an extra layer of fees on their life-cycle funds.

It is also an open question how much personalization is needed to provide investors with reasonable asset allocation advice. It is possible that heterogeneity in human capital risk and in risk tolerance is such that a relatively small number of model asset allocation portfolios suffice to serve most investors needs.

There are also ways to help capture more investor diversity at a relatively lower cost than full personalization. One is the suggestion already mentioned above of creating “aggressive,” “moderate,” and “conservative” life-cycle funds to capture disparity in risk tolerance. This raises the question of whether employees can identify their own risk tolerance. However, employees might be able to better identify which risk-return tradeoff they are comfortable with if that tradeoff is framed as questions about potential replacement ratios of their current income at retirement and uncertainty about those ratios.

Another way is for sponsors of DC pension plans to consider adopting life-cycle funds specifically designed for their firms. These funds might be able to better capture the human capital risk characteristics of their typical employee, particularly the correlation of wages with stock returns. For example, these company-tailored funds might consider investing in stock portfolios which underweigh the exposure to stocks in the industry where the company competes and avoid exposure to company stock altogether. They might also adopt asset allocation paths whose equity tilts take into account the correlation of wages in the industry with aggregate stock returns.

Wealth Heterogeneity and Tax Efficiency

Investors are heterogeneous not only regarding their human capital and risk tolerance. They also differ along other important dimensions such as wealth and tax status. Many investors, particularly small investors, do not typically save outside their retirement account, except to own a home and perhaps to hold some precautionary savings. Thus it might make sense for these investors to simply allocate their DC plan contributions to a life-cycle fund which appropriately reflects their risk tolerance and retirement horizon—or their life expectancy if they expect to receive traditional pension benefits in retirement. Sponsors can allow this practice by including life-cycle funds in their plan investment options and, more importantly, encourage it by making these funds the default allocation of the plan.

It is interesting to consider how home ownership should affect asset allocation decisions. A home is both an asset and a durable consumption good, since it provides its owner with a stream of housing services. Since a home provides its owner with insurance against fluctuations in the cost of housing services, one can view a home as a real (or inflation-indexed) consol bond that pays coupons in the form of housing services. As such, home ownership might make long-horizon investors more willing to hold equities in their financial portfolios.

At short horizons, however, home prices fluctuate, and these fluctuations might be positively correlated with investors' labor earnings. This makes residential housing a risky asset and can make home owners less willing to take equity risk in their financial portfolios. However, empirically home price volatility and its correlation with labor earnings does not seem large enough to significantly impact asset allocation in practice.³⁰

Tax considerations, however, can have a significant impact on how investors “locate” their assets. Many employees, particularly those in the upper levels of the wage distribution, have the ability to save outside their retirement accounts. Tax efficiency considerations make

life-cycle funds an inappropriate investment vehicle for these investors, even if age-based investing is still an appropriate asset allocation strategy for them to follow.

Instead, these investors should use regular funds to build their own tax-efficient life-cycle allocation strategy. Tax regulations typically tax fixed-income assets more heavily than equities. From this perspective, investors should place as much of their fixed-income asset allocation as possible in their tax-exempt retirement accounts, and equities in their taxable account.³¹

For this reason, life-cycle funds should probably not be the only investment option available to investors within a DC plan, even if they are appropriately designed to match the human capital characteristics and risk tolerance of plan participants. In particular, tax efficiency considerations suggest that plan participants who have the ability to save outside the plan should have plain vanilla funds available to them, particularly fixed-income investment options, so they can make their own asset allocation plan and, given this plan, locate these assets in their tax-exempt and taxable accounts in a tax efficient manner.

<A>Conclusions<A>

This chapter has reviewed recent advances in academic models of asset allocation for long-term investors and explored their implications for the design of investment products that help investors save for retirement, particularly life-cycle funds and life-style funds. The modern theory of long-term asset allocation shows that the type of “risk-based” and “age-based” asset allocation strategies that characterize life-style funds and life-cycle funds respectively are conceptually sound under specific circumstances relating to investment opportunities and investors’ wealth. Simultaneously, it also offers a number of suggestions about both the design of these funds and the types of investors for whom these funds are appropriate.

Real interest-rate risk (or reinvestment risk) can give rise to “risk-based” asset allocation strategies. This risk makes short-term bonds (or cash) risky assets and long-term inflation-indexed bonds (or TIPS in the United States) the riskless asset at long horizons. Thus it is optimal for long-term investors to increase their allocation to these bonds as they become increasingly risk averse. Thus these considerations provide support for the “risk-based” approach of life-style funds, which provide investors with a menu of funds that differ in their relative allocation to bonds, and thus allow them to select the fund that best fits their risk tolerance.

However, there is an important caveat. Long-term nominal bonds are subject to inflation risk, and they are safe assets at long-horizons only to the extent that this risk is low, in which case they become close substitutes for inflation-indexed bonds. Life-style and life-cycle funds should therefore consider increasing substantially their allocation to inflation-indexed bonds at the expense of their current allocations to nominal bonds. Their current fixed-income allocations implicitly assume that inflation risk will be insignificant in the foreseeable future.

The interaction of human wealth (the capitalized value of expected future labor earnings) with financial wealth can give rise to “age-based” asset allocation strategies of the sort used by life-cycle funds. However, these strategies are appropriate only for working investors whose labor earnings exhibit low volatility and low correlation with equity returns. For these investors it is optimal to allocate a large fraction of their savings to equities when they have long retirement horizons and their “bond-like” human wealth accounts for most of their wealth, and to decrease this allocation as their retirement horizon shortens and their human wealth is depleted.

Employees with volatile labor earnings or labor earnings that are highly correlated with equity returns should avoid investing in the current generation of life-cycle funds, which exhibit significant equity tilts. For these investors, their human wealth is less “bond-like” and more

“equity-like.” Therefore they already have exposure to equities through their human wealth and should avoid excessive exposure, or any exposure at all, to equities in their portfolios. Since the correlation of labor earnings with stock returns is likely to be similar for employees within the same industry or company, these considerations suggest that there is a benefit to the creation of industry-specific or company-specific life-cycle funds.

Mutual fund companies might want to consider offering life-cycle funds that exhibit different equity tilts. That is, they might want to offer “conservative,” “moderate,” and “aggressive” life-cycle funds. These funds will help capture investor heterogeneity in risk tolerance and in the correlation between human wealth and equity returns.

Stock return predictability, or mean-reversion, makes it optimal for investors to strategically tilt their portfolios toward equities at long horizons. However, it also suggests that investors should tactically change the equity tilt of their portfolios based on market conditions. It is logically inconsistent to invest more in equities because of mean-reversion, but then ignore the short-term implications of holding such a view of the world.

These considerations do not mean that mutual fund companies should discard their current life-cycle fund offerings, or that DC plan sponsors should ignore them. Instead, they offer suggestions on how to modify the current design. In evaluating the merit of an investment vehicle, one needs to consider which alternatives are realistically available to investors.

One alternative is the status quo. The U.S. retirement system is moving toward a system fundamentally based on DC pension plans. In that system, employees are responsible for financing their own retirement. The existing empirical evidence indicates that many DC plan participants, particularly those on the low end of the education and income distribution, appear to make suboptimal saving and investing decisions. In particular, they exhibit a significant degree

of inertia in their decisions, and they disproportionately tend to adopt the default investment option offered in their plans, which very often is cash in the form of a money market account.

Thus the status quo for many investors is investing in a money market account. One can argue that life-cycle funds, even if imperfectly designed, are a better investment choice for long-term investors than a money market account. As such, employers could use the inertia that overwhelms so many investors positively and adopt life-cycle funds, possibly tailored to their own needs, as default investment options.

Another alternative would be to implement individually managed accounts for everyone. While this might be the best approach to capture individual characteristics regarding risk tolerance, human wealth, tax status, and other types of wealth, these accounts are costly to manage. This cost is high enough at this point that they are not a plausible alternative for the vast majority of working investors. Life-cycle funds, on the other hand, are inexpensive to manage, and most mutual companies do not charge fees on top of the fees they already charge to the underlying funds. A more diverse menu of life-cycle funds might be a more cost-effective way of avoiding the “one-size fits all” approach of the current generation of life-cycle funds. This menu can also help as employee circumstances (for example, job changes) and, thus, demand for equities change over their life cycle.

A third alternative would be to educate investors so they can make their own choices, adapted to their personal characteristics. However, the existing empirical evidence suggests that it is investors on the low end of the income and education distribution that tend to make more mistakes. There is also evidence that the average person has difficulty understanding relatively simple financial concepts and ideas. Thus one has to wonder to what extent it is cost effective to

try to educate people to become sophisticated investors. However, it might be cost-effective to educate people to be discriminating consumers of financial products and services.

Life-style funds and life-cycle funds are part of a first generation of products that try to help individuals meet their financial goals, without requiring them to become investment professionals. Financial engineering is in many ways conceptually and practically as difficult as other types of engineering. Just as we do not require people to build their own personal computers or electronic devices, we should probably not require them to build their own investment strategies. And just as people can become highly discriminating buyers of electronic products, despite the fact that they are not engineers, they might also become discriminating consumers of financial products and services.

Until the next generation of investment products is available, individually managed accounts are a reality for everyone, and investment education becomes widespread, we need to evaluate whether life-cycle funds can improve on the status quo. Arguably they do, and as such, adopting them as default investment options in DC pension plans might help a significant number of individuals. Doing nothing just because these funds are not perfect might be a worse solution than adopting them. The best is often the enemy of the good.

References

- Barberis, N. C. 2000. "Investing the Long Run When Returns Are Predictable," *Journal of Finance* 55: 225–264.
- Benzoni, L., P. Collin-Dufresne, and R. S. Goldstein. Forthcoming. "Portfolio Choice Over the Life-Cycle When the Stock and Labor Markets Are Cointegrated." *Journal of Finance*.
- Bernstein, P. L. 1992. *Capital Ideas: The Improbable Origins of Modern Wall Street*. New York: Free Press.
- Brennan, M. J. 1998. "The Role of Learning in Dynamic Portfolio Decisions." *European Finance Review* 1: 295–306.
- Bodie, Z., R. Merton, and W. Samuelson. 1991. "Labor Supply Flexibility and Portfolio Choice in a Life Cycle Model." *Journal of Economic Dynamics and Control* 16: 427–449.
- Campbell, J. Y., Y. L. Chan, and L. M. Viceira. 2003. "A Multivariate Model of Strategic Asset Allocation." *Journal of Financial Economics* 67(1):41-80
- Campbell, J. Y., J. Cocco, F. Gomes, P. J. Maenhout, and L. M. Viceira. 2001. "Stock Market Mean-Reversion and the Optimal Equity Allocation of a Long-Lived Investor." *European Finance Review* 5: 269–292.
- Campbell, J. Y., K. Serfaty-de Medeiros, and L. M. Viceira. 2007. "Global Currency Hedging." NBER Working Paper 13088, National Bureau of Economic Research, Cambridge, MA.
- Campbell, J. Y., and R. Shiller. 1988. "Stock Prices, Earnings, and Expected Dividends." *Journal of Finance* 43: 661–676.
- , 1998. "Valuation Ratios and the Long-Run Stock Market Outlook." *Journal of Portfolio Management* 28(2): 11-26

- Campbell, J. Y., and S. Thompson. Forthcoming. “Predicting Excess Stock Returns Out of Sample: Can Anything Beat the Historical Average?” *Review of Financial Studies*.
- Campbell, J. Y., and L. M. Viceira. 1999. “Consumption and Portfolio Decisions When Expected Returns Are Time Varying.” *Quarterly Journal of Economics* 114: 433–495.
- . 2001. “Who Should Buy Long-Term Bonds?” *American Economic Review* 91: 99–127.
- . 2002. *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors*. New York: Oxford University Press.
- . 2005. “The Term Structure of the Risk-Return Tradeoff.” *Financial Analysts Journal*, 61(1): 34-44.
- Chan, Y. L., and L. M. Viceira. 2000. “Asset Allocation with Endogenous Labor Income: The Case of Incomplete Markets.” Mimeo, Harvard University.
- Cheng, R., and J. Shelton. 2004. “Putting Lifecycle Investing Theory into Practice.” Investment report, Fidelity Investments.
- Cocco, J. F. 2005. “Portfolio Choice in the Presence of Housing.” *Review of Financial Studies* 18: 535–567.
- Cocco, J. F., F. J. Gomes, and P. J. Maenhout. 2005. “Consumption and Portfolio Choice over the Life Cycle.” *The Review of Financial Studies* 18: 491–533.
- Cochrane, J. H. Forthcoming. “The Dog That Did Not Bark: A Defense of Return Predictability.” *Review of Financial Studies*.
- Dammon, R. M., C. H. Spatt, and H. H. Zhang. 2004. “Optimal Asset Location and Allocation with Taxable and Tax-Deferred Investing.” *Journal of Finance* 59(3): 999-1038.
- Dimson, E., P. Marsh, and M. Staunton. 2002. *Triumph of the Optimists: 101 Years of Global Investment Returns*. Princeton: Princeton University Press.

- Edwards, R. D. 2005. "Health Risk and Portfolio Choice." Mimeo, University of California, Berkeley, and RAND Corporation.
- Fama, E., and K. French. 1988a. "Permanent and Temporary Components of Stock Prices." *Journal of Political Economy* 96: 246–273.
- , 1988b. "Dividend Yields and Expected Stock Returns." *Journal of Financial Economics* 22: 3–27.
- French, K. R., and J. M. Poterba. 1991. "Investor Diversification and International Equity Markets." *American Economic Review* 81(2): 222–226.
- Goyal, A., and I. Welch. Forthcoming. "A Comprehensive Look at the Empirical Performance of Equity Premium Prediction." *Review of Financial Studies*.
- Greer, Boyce. 2004. "The Case for Age-Based LifeCycle Investing." Viewpoint Investment Concepts White Paper, Fidelity Investments.
- Jurek, J., and L. M. Viceira. 2006. "Optimal Value and Growth Tilts in Long-Horizon Portfolios." NBER Working Paper 12017, National Bureau of Economic Research, Cambridge, MA.
- Kotlikoff, L., F. J. Gomes, and L. M. Viceira. 2006. "The Excess Burden of Government Indecision." Mimeo, Harvard University.
- Lewellen, J. 2004. "Predicting Returns with Financial Ratios." *Journal of Financial Economics* 74: 209–235.
- Markowitz, H. 1952. "Portfolio Selection." *Journal of Finance* 7: 77–91.
- Merton, R. C. 1969. "Lifetime Portfolio Selection Under Uncertainty: the Continuous-time Case." *Review of Economics and Statistics* 51: 247–257

- , 1971. "Optimum Consumption and Portfolio Rules in a Continuous-time Model." *Journal of Economic Theory* 3: 373–413.
- Mottola, G., and S. Utkus. 2007. "Red, Yellow, and Green: Measuring the Quality of 401(k) Portfolio Choices." This volume.
- Poterba, J., J. Rauh, S. Venti, and D. Wise. 2005. "Lifecycle Asset Allocation Strategies and the Distribution of 401(k) Retirement Wealth." Working paper, MIT.
- Poterba, J., and L. Summers. 1988. "Mean Reversion in Stock Returns: Evidence and Implications." *Journal of Financial Economics* 22: 27–60.
- Poterba, J., S. Venti, and D. Wise. 2007. "The Changing Landscape of Pensions in the United States." This volume.
- Samuelson, P. A.. 1969. "Lifetime Portfolio Selection by Dynamic Stochastic Programming." *The Review of Economics and Statistics* 51: 239–246.
- , 1991. "Long-run Risk Tolerance When Equity Returns Are Mean Regressing: Pseudoparadoxes and Vindication of 'Businessman's Risk,'" in *Money, Macroeconomics, and Economic Policy: Essays in Honor of James Tobin*, ed. William C. Brainard, William D. Nordhaus, and Harold W. Watts, 181-204. Cambridge, MA: MIT Press.
- Siegel, J. 1998. *Stocks for the Long Run*, 2nd ed. McGraw-Hill.
- Tobin, J. 1958. "Liquidity Preference as Behavior Towards Risk." *Review of Economic Studies* 25: 68–85.
- Viceira, L. M. 2001. "Optimal Portfolio Choice for Long-Horizon Investors with Nontradable Labor Income." *Journal of Finance* 56(2): 433–470

Viceira, L. M. 2007. “The Vanguard Group, Inc., in 2006 and Target Retirement Funds.” HBS Case 9-207-129, Harvard Business School Publishing.

Wachter, J. A., and M. Warusawitharana. 2007. “Predictable Returns and Asset Allocation: Should a Skeptical Investor Time the Market?” Working paper, the Wharton School, University of Pennsylvania.

Xia, Y. 2001. “Learning about Predictability: The Effects of Parameter Uncertainty on Dynamic Asset Allocation.” *Journal of Finance* 56: 205–246.

Yao, R., and H. H. Zhang. 2005. “Optimal Consumption and Portfolio Choices with Risky Housing and Borrowing Constraints.” *Review of Financial Studies* 18: 197–239.

Table 5.1. Fidelity Freedom Funds asset allocation (May 30, 2006)

Underlying Fidelity Fund	Income	Freedom Fund										
		2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Domestic Equity Funds												
Blue Chip Growth	3.0%	3.6%	5.8%	5.8%	7.2%	8.1%	8.9%	9.7%	10.0%	10.0%	10.4%	10.5%
Disciplined Equity	3.1	4.0	5.9	6.0	7.1	8.2	8.9	9.8	10.2	10.0	10.4	10.5
Equity-Income	3.1	4.0	5.9	6.0	7.1	8.3	8.9	9.8	10.1	10.0	10.4	10.5
Fidelity Fund	1.6	1.7	1.9	3.5	2.1	4.9	2.5	5.2	2.5	3.5	0.0	0.0
Growth & Income Portfolio	3.2	3.9	6.5	6.5	7.9	9.0	9.9	10.8	11.3	11.1	11.8	11.9
Fidelity Growth	2.0	2.6	3.7	3.9	4.6	5.2	5.6	6.2	6.3	6.4	6.7	6.8
Company Fund	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mid-Cap Stock	2.1	2.7	3.8	4.1	4.6	5.5	5.7	6.3	6.6	6.4	6.7	6.8
OTC Portfolio	1.6	1.9	2.9	3.0	3.6	4.1	4.5	4.9	5.0	5.1	5.3	5.4
Small Cap Growth	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3	0.4	0.4
Small Cap Independence	0.3	0.2	0.8	0.7	1.0	1.1	1.2	1.3	1.4	1.4	1.4	1.4
Small Cap Value Fund	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Value Fund	0.9	0.7	2.3	1.9	2.8	2.9	3.4	3.5	3.9	3.8	5.3	5.4
<i>Total</i>	<i>21.1</i>	<i>25.5</i>	<i>39.9</i>	<i>41.8</i>	<i>48.5</i>	<i>57.9</i>	<i>60.1</i>	<i>68.2</i>	<i>68.1</i>	<i>68.4</i>	<i>69.2</i>	<i>70.0</i>
International Equity Funds												
Diversified International	0.0	0.2	1.9	1.9	2.6	3.0	3.3	3.7	3.9	4.1	4.9	5.0
Europe	0.0	0.2	2.7	2.6	3.6	4.2	4.4	5.1	5.2	5.5	6.8	7.0
Japan	0.0	0.1	0.8	0.8	1.1	1.2	1.4	1.5	1.6	1.7	1.9	2.0
Overseas	0.0	0.1	1.9	1.9	2.6	3.0	3.3	3.7	3.8	4.1	4.9	5.0
Southeast Asia	0.0	0.0	0.4	0.4	0.5	0.6	0.7	0.8	0.8	0.8	1.0	1.0
<i>Total</i>	<i>0.0</i>	<i>0.6</i>	<i>7.7</i>	<i>7.6</i>	<i>10.4</i>	<i>12.0</i>	<i>13.1</i>	<i>14.8</i>	<i>15.3</i>	<i>16.2</i>	<i>19.5</i>	<i>20.0</i>
Investment Grade Fixed Income Funds												
Government Income	13.5	13.0	12.1	12.8	10.2	7.9	6.4	3.4	2.9	1.8	5.0	5.0
Intermediate Bond	8.8	8.6	8.3	8.6	7.1	5.4	4.5	2.3	2.0	1.2	5.0	5.0

Underlying Fidelity Fund	Income	Freedom Fund										
		2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Investment Grade Bond	13.9	13.4	13.1	13.4	11.2	8.5	7.1	3.7	3.1	1.9	0.4	0.0
Strategic Real Return	1.0	0.9	2.0	1.2	2.0	1.0	1.3	0.4	0.6	0.3	0.3	0.0
<i>Total</i>	37.2	35.9	35.5	36.0	30.5	22.8	19.3	9.8	8.6	5.2	10.7	10.0
High Yield Fixed Income Funds												
Capital & Income	0.9	0.8	2.5	2.6	3.3	3.6	3.8	3.6	4	5.1	0.5	0
High Income	0.8	0.8	2.5	2.5	3.2	3.6	3.7	3.6	4	5.1	0.1	0
<i>Total</i>	1.7	1.6	5	5.1	6.5	7.2	7.5	7.2	8	10.2	0.6	0
Short Term Funds												
Retirement Money Market Portfolio	26.3	25.6	7.5	5.8	2.6	0.1	0	0	0	0	0	0
Short-Term Bond	13.7	10.8	4.4	3.7	1.5	0	0	0	0	0	0	0
<i>Total</i>	40	36.4	11.9	9.5	4.1	0.1	0	0	0	0	0	0

Source: Fidelity Freedom Funds Prospectus, May 30, 2006.

Table 5.2. Vanguard Target Retirement Funds asset allocation (June 7, 2006)

Underlying Vanguard Fund	Income	Target Retirement Fund									
		2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Total Stock Market Index	24.0%	40.0%	48.0%	53.3%	60.0%	66.0%	72.0%	72.0%	72.0%	72.0%	72.0%
European Stock Index	3.5	5.9	7.1	7.9	8.8	9.7	10.6	10.6	10.6	10.6	10.6
Pacific Stock Index	1.7	2.8	3.3	3.7	4.2	4.6	5.0	5.0	5.0	5.0	5.0
Emerging Markets Stock Index	0.8	1.3	1.6	1.8	2.0	2.2	2.4	2.4	2.4	2.4	2.4
Total Bond Market Index	45.0	40.0	40.0	33.3	25.0	17.5	10.0	10.0	10.0	10.0	10.0
Inflation-Protected Securities	20.0	10.0	0	0	0	0	0	0	0	0	0
Prime Money Market	5.0	0	0	0	0	0	0	0	0	0	0

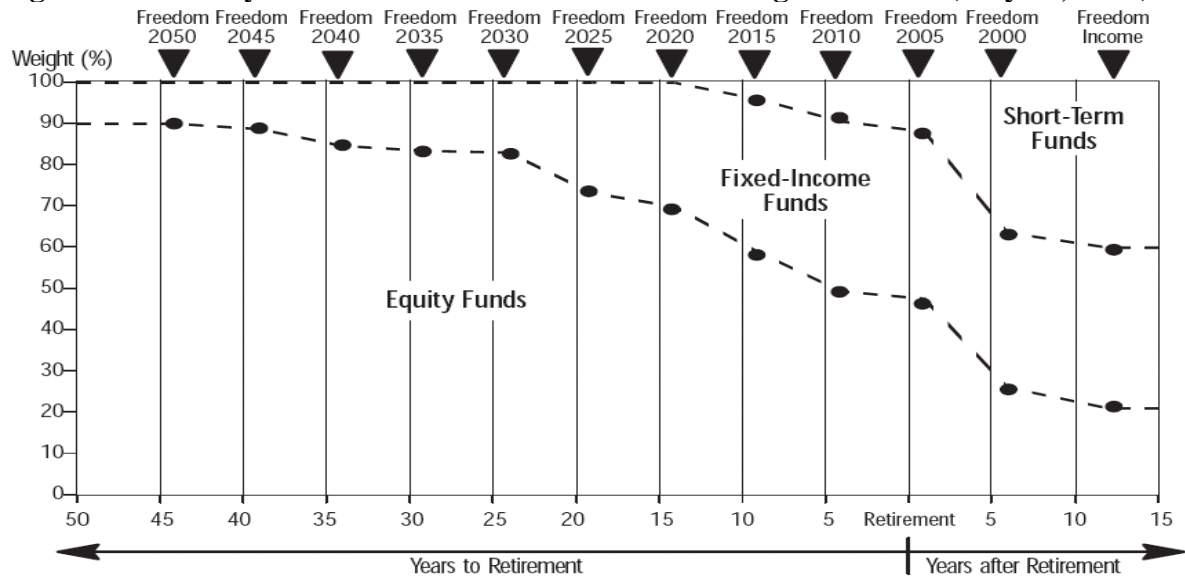
Source: The Vanguard Group.

Table 5.3. Optimal percent allocation to stocks, bonds, and cash for investors with different degrees of relative risk aversion.

Relative risk aversion	Equity	Indexed	Cash	Equity	Nominal	Cash
<i>(A) 1952-99</i>						
1	100	0	0	100	0	0
2	100	0	0	100	0	0
5	65	35	0	73	6	21
10	32	68	0	35	8	57
5,000	0	94	6	0	10	90
<i>(B) 1983-99</i>						
1	100	0	0	100	0	0
2	86	14	0	87	13	0
5	38	62	0	36	64	0
10	22	78	0	19	81	0
5,000	0	93	7	1	98	1

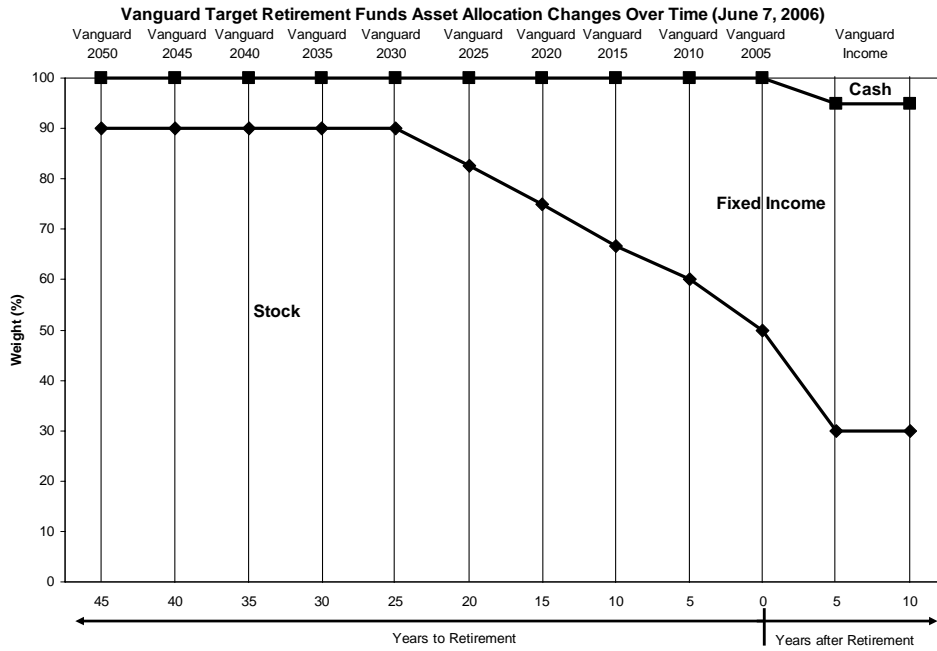
Source: Campbell and Viceira (2002), Table 3.3.

Figure 5.1. Fidelity Freedom Funds asset allocation change over time (May 30, 2006)



Source: Fidelity Freedom Funds Prospectus, May 30, 2006.

Figure 5.2. Vanguard Target Retirement Funds asset allocation change over time (June 7, 2006)



Source: The Vanguard Group.

Figure 5.3. Annualized percent standard deviation of monthly real returns on U.S. stocks, 1959.01-2004.12.

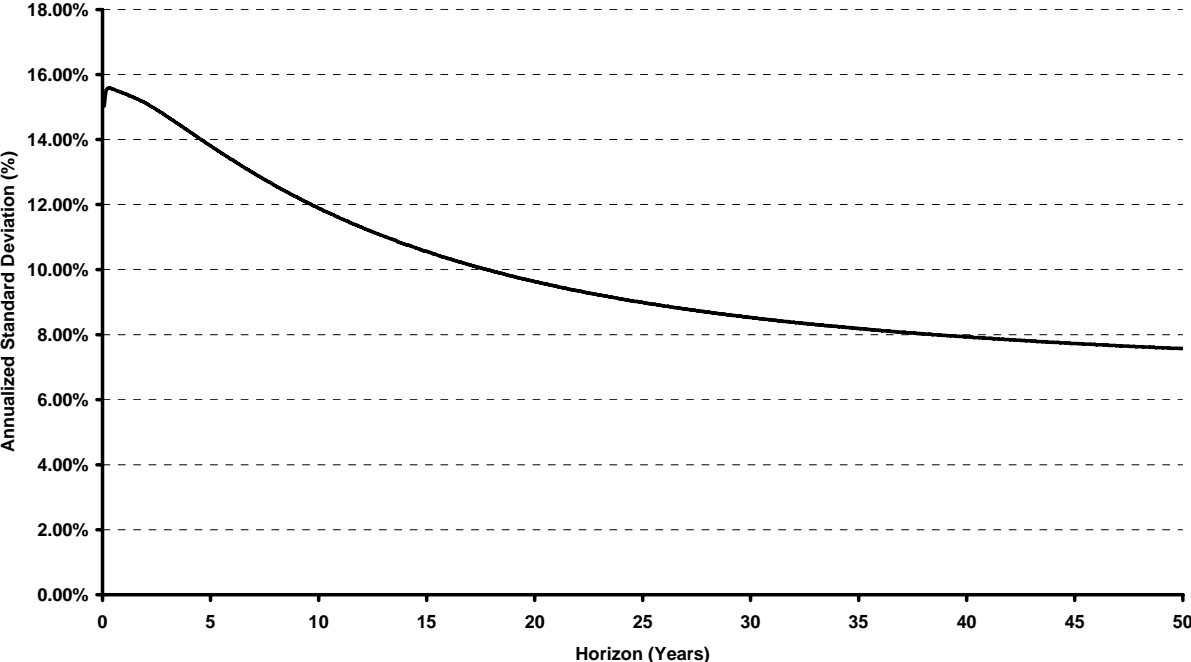


Figure 5.4. Spread of annualized returns at different horizons, 1926–2005. This figure plots annualized mean returns on U.S. stocks, bonds, and T-bills at horizons of 5, 10, and 20 years.

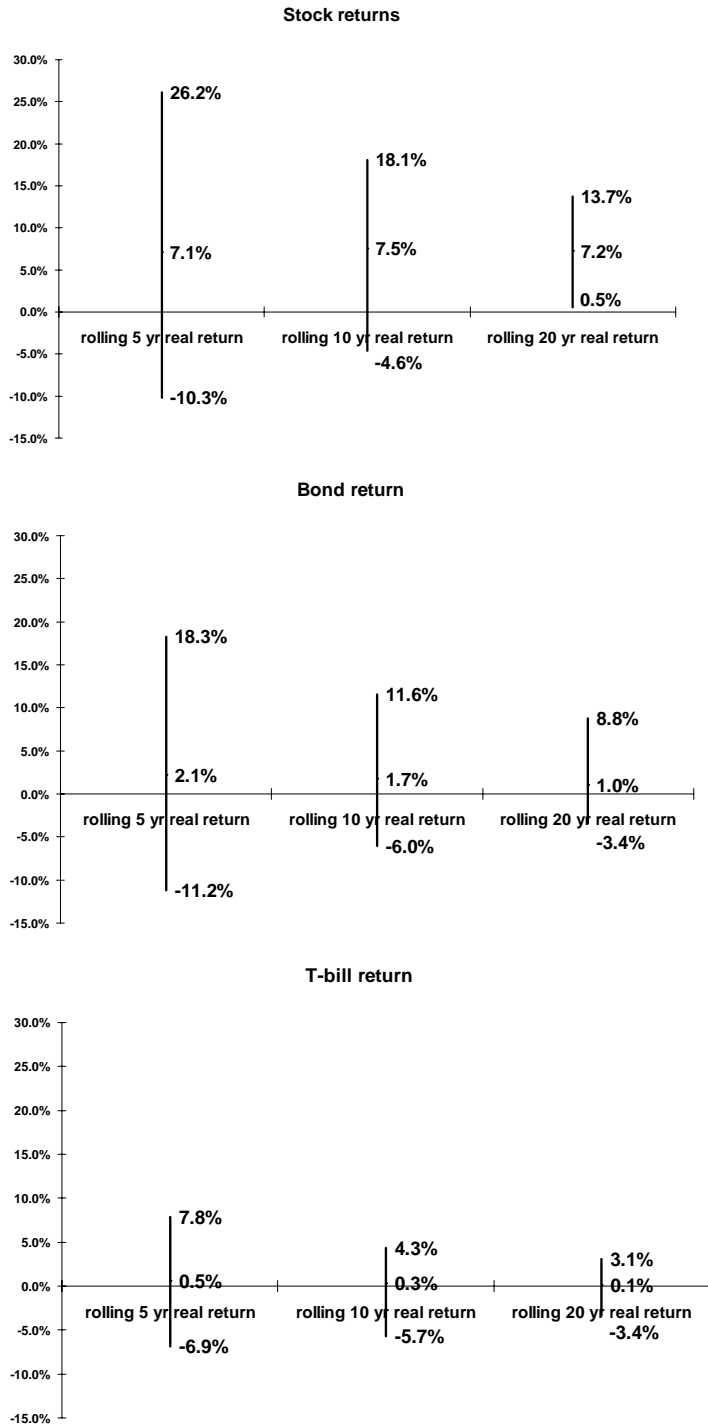
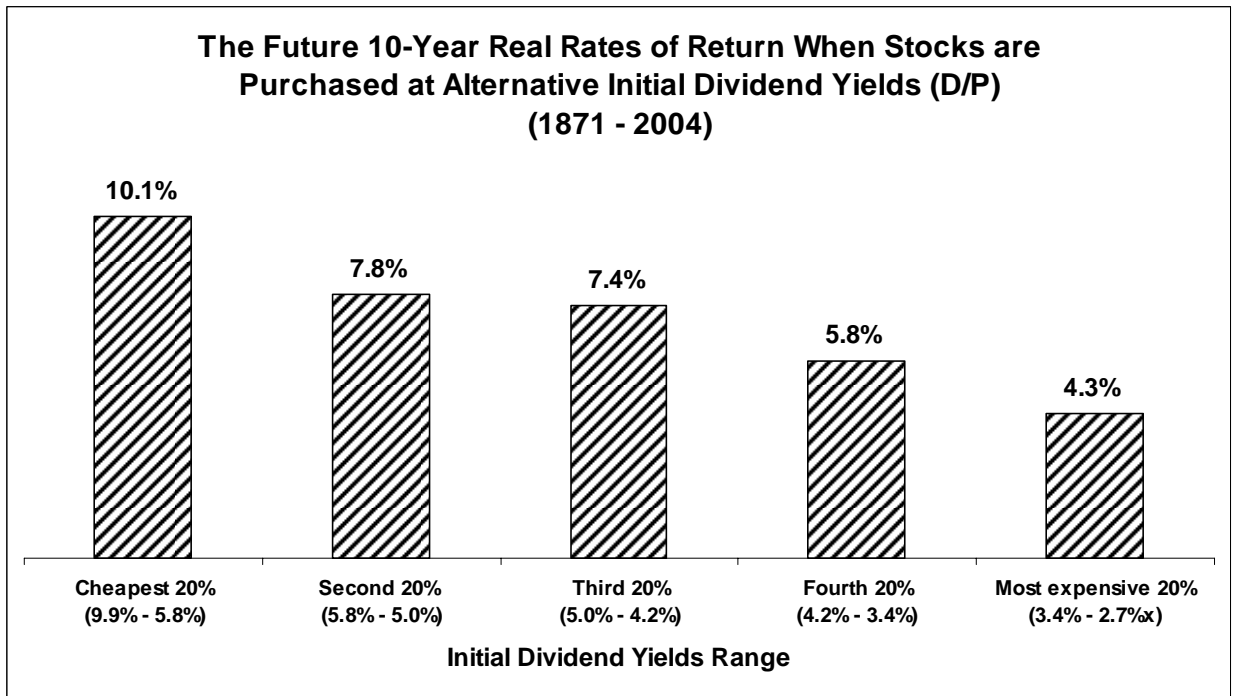
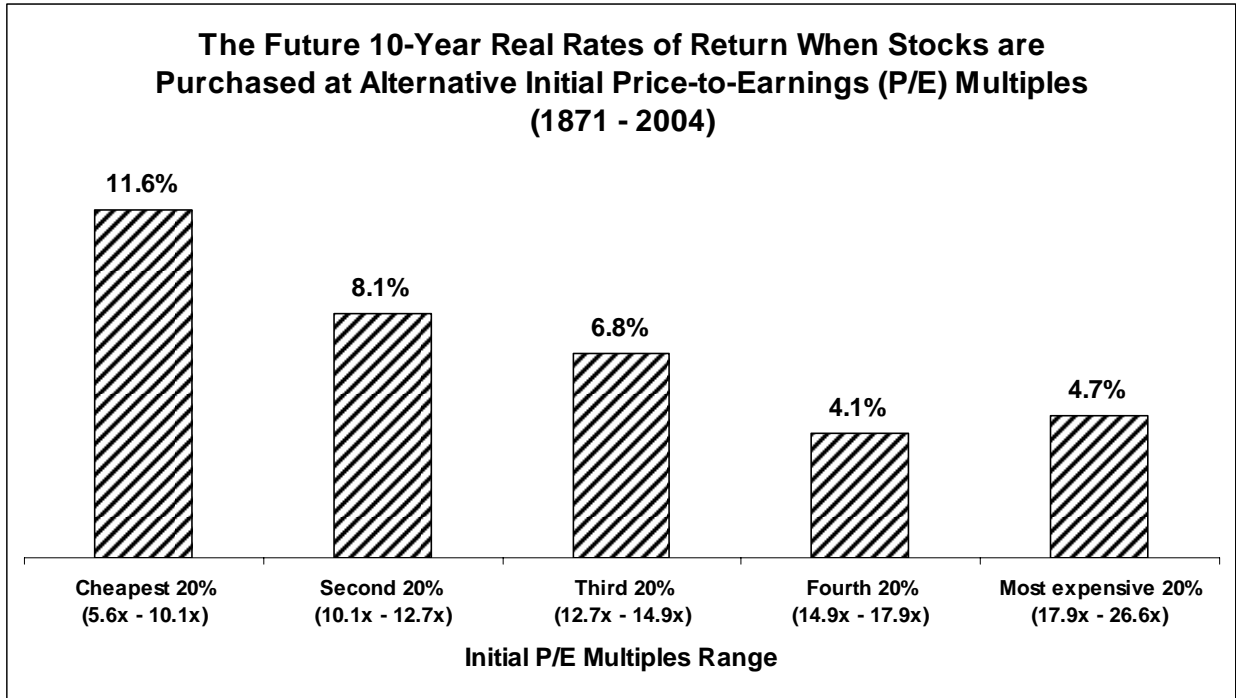
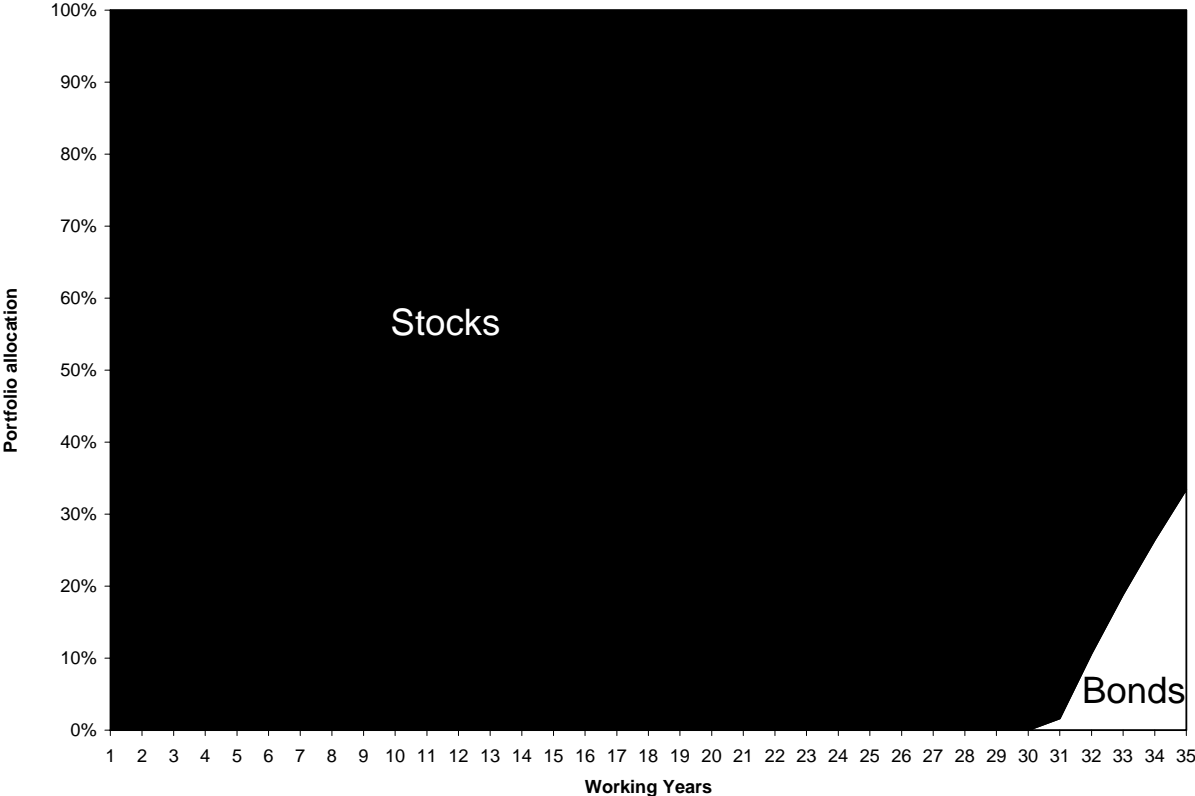


Figure 5.5. The empirical relation between smoothed price-to-earnings (P/E) multiples and dividend yields (D/P) and future 10-year real returns on the S&P 500, 1871–2004. P/E multiples are based on 10-year moving averages of earnings.



Source: Stock market annual data from Professor Robert Shiller.

Figure 5.6. Life-cycle allocation to stocks and bonds when human wealth is riskless.



Endnotes

¹ For a more complete description of the changes in the U.S. pension landscape, see the chapter by Poterba, Venti, and Wise in this volume.

² See Viceira (2007).

³ For a more complete description of employee savings and investment choices in DC plans, see the chapter by Mottola and Utkus in this volume.

⁴ See the chapter by Mottola and Utkus in this volume.

⁵ Specifically, with 60 percent of its assets, the fund seeks to track the investment performance of the Morgan Stanley Capital International (MSCI) U.S. Broad Market Index, which represents 99.5 percent or more of the total market capitalization of all the U.S. common stocks regularly traded on the New York and American Stock Exchanges and the Nasdaq over-the-counter market. With 40 percent of its assets, the fund seeks to track the investment performance of the Lehman Brothers Aggregate Bond Index, which measures a wide spectrum of public, investment-grade, taxable, fixed income securities in the United States—including government, corporate, and international dollar-denominated bonds, as well as mortgage-backed and asset-backed securities, all with maturities of more than one year.

⁶ See Markowitz (1952).

⁷ See Tobin (1958).

⁸ See Merton (1969, 1971) and Samuelson (1969, 1991).

⁹ See Markowitz (1952).

¹⁰ See Campbell and Viceira (2001) and Campbell and Viceira (2002), chapter 3.

¹¹ These are allocations where the weight of each asset class is constrained to be between 0 percent and 100% percent.

¹² See Campbell and Shiller (1998). Earlier work on mean-reversion includes Fama and French (1988a,b), Campbell and Shiller (1988), and J. Poterba and Summers (1988).

¹³ The line shows the volatility (or standard deviation) of stock returns at different holding horizons properly scaled by dividing by the square root of the number of years in the holding horizon.

¹⁴ See Dimson, Marsh, and Staunton (2002)

¹⁵ See Siegel (1998), Greer (2004), and Cheng and Shelon (2004).

¹⁶ See Campbell and Viceira (2005) and Jurek and Viceira (2006).

¹⁷ In a world of constant expected return and risk, the volatility of K-holding period returns is precisely equal to the volatility of 1-period returns times the square root of K, the number of holding periods. Since the line shown in Figure X is the volatility of K-holding returns divided by the square root of the number of holding periods, this line should be flat in that world.

¹⁸ Earnings and dividends in these ratios are averages over the previous ten years, to smooth out seasonal and business-cycle variation in these variables.

¹⁹ See Campbell and Viceira (1999, 2002), Campbell, Chan, and Viceira (2003), and Campbell et al. (2001).

²⁰ See Jurek and Viceira (2006).

²¹ See Goyal and Welch (forthcoming).

²² See Campbell and Thompson (forthcoming), Cochrane (forthcoming), and Lewellen (2004).

²³ See Barberis (2000), Brennan (1998), Xia (2001), and Wachter and Warusawitharana (2007).

²⁴ This is approximately the current yield on long-term inflation-indexed bonds. Note that the implied equity premium (around 3.7 percent) is low relative to the historical average equity premium, which is around 6.5 percent.

²⁵ See Viceira (2001). See also chapter 6 of Campbell and Viceira (2002).

²⁶ However, uncertainty about future pension benefits can make investors less willing to take equity risk. See Kotlikoff, Gomes, and Viceira (2006).

²⁷ See French and Poterba (1991).

²⁸ See Jurek and Viceira (2006).

²⁹ See Bernstein (1992).

³⁰ See Cocco (2005) and Yao and Zhang (2005).

³¹ See Dammon, Spatt, and Zhang (2004).