FINANCIAL SERVICES REVIEW

Financial Services Review 11 (2002) 117–133

# Equity Allocations and the Investment Horizon: A Total Portfolio Approach

R. Douglas Van Eaton, James Conover*

*Texas Christian University and University of North Texas, Denton, TX 76203-5339, USA*

Accepted 24 April, 2002

**Abstract**

We offer a streamlined life-cycle model that provides support for the common advice given to investors to hold large initial equity allocations among financial assets and then reduce them as retirement nears. We examine how total portfolio wealth varies at different horizons. We find that if the financial component of a total retirement portfolio is large (small), compared to anticipated future contributions, then the equity allocation should be reduced (increased) to target that individual's desired risky asset allocation of total wealth. Our examples and historical tests favor allocation strategies that depend on individual financial circumstances and portfolio horizons. But, somewhat surprisingly, even highly risk-averse individuals should choose to hold all equity retirement portfolios when beginning to save for retirement. © 2002 Academy of Financial Services. All rights reserved.

*JEL Classification:* G11; D12; J26

*Keywords:* Total wealth portfolio; Asset allocation; Long time horizon; Retirement accounts; Life-cycle hypothesis

## 1. Introduction

An investor's anticipated holding period, or investment horizon, is often seen as the most important single factor affecting the asset allocation decision for financial asset holdings. Financial advisors and mutual fund sales literature commonly recommend that younger investors allocate greater proportions of their financial retirement assets to equities than older investors. Usually, the concept that equity risk

* Corresponding author. Tel: +1-940-565-3061.
*E-mail address:* conoverj@unt.edu (J. Conover).

is somehow diminished when investment horizons are longer, an effect often called "time diversification," justifies this recommendation.

However, as several articles in the personal financial management and investments literature have discussed, often heatedly, this justification remains controversial (Kritzman, 1994; Samuelson, 1989). As an example of one objection to this justification, we observe that the risk of equity holdings, as measured by the variance of end-of-horizon wealth, *increases* with the length of the investment horizon, using both theoretical and historical evidence.

Other justifications don't depend on the claim that longer horizons mitigate equities risk. These alternative explanations, for strategies recommending reducing equity allocations as retirement approaches, rely on complex models of the asset allocation decision. The most sophisticated models allow for investor decisions regarding how much and how long to work; how much to save; and how to allocate retirement account financial assets at different horizons.

We focus on one of the implications of such a model: that an investor's total wealth, including the present value of future retirement plan contributions, must be considered in a "total wealth portfolio" approach to the asset allocation decision. The total wealth portfolio approach lets us examine the financial assets accumulated in a retirement account separately from other sources of retirement wealth. If the effect of anticipated future savings is the primary justification for allocating assets between debt and equities, recommendations that use this longevity information help us project a retirement saver's earnings stream. These recommendations are not based specifically on a retirement saver's age or time until retirement, but, instead, on how a person's total wealth portfolio changes from human capital to financial assets.

An asset allocation strategy that focuses only, or primarily, on the length of an investor's investment horizon may lead to poor results for that investor if other important factors are ignored. Clearly, an appropriate asset allocation strategy should use all factors that lead to good results for an investor. Reducing financial asset equity allocations in retirement accounts over time is usually assumed to be appropriate, by the traditional advice given to many investors. The justification for adopting this strategy is important as it affects our recommendations for financial asset equity allocations for other investors with different types of total wealth portfolios.

First, we discuss recent literature describing equity allocations and investment horizon length. Next, we describe how focusing on a total portfolio of retirement assets, including anticipated future retirement plan contributions, justifies reducing optimal equity allocations in retirement accounts over time. Third, a spreadsheet analysis, based on a simplified model, shows the practical use of the total wealth portfolio approach to asset allocation. Fourth, examples based on historical equity returns illustrate the likely benefits of a decreasing equity allocation strategy in practice. Fifth, we discuss and summarize the implications of the analysis.

## 2. Equity allocation and the investment horizon

Usually, arguments that equity risk is lower when investment horizons are longer justify reducing equity allocations as the investment horizon shortens. This rationale has been the subject of spirited debate, and to many is still an unresolved issue. An excellent summary of the various arguments on both sides of this debate appears in Connelly (1996). In these arguments, various definitions of portfolio "risk" justify a positive relation between financial assets' equity allocations and length of investment horizon. While we do not review these arguments here, arguments on both sides of the so-called time diversification debate are related to age-based asset allocation strategies that do not depend on the notion of time diversification.

More recently, some researchers argue that shortfall risk, or the probability that holding-period returns will fall short of some target or benchmark return, is the appropriate equity risk measure. Consequently, if investors base their allocation decisions on this risk measure, some researchers argue that equities are less risky when held over longer holding periods because shortfall risk is lower for longer time periods. However, like many other suggested rationales for reducing equity allocations over time based on risk measures, the shortfall risk measure is not without theoretical and practical problems.

For the specific case of equity return shortfalls below the risk-free rate, Bodie (1995) uses option-pricing theory to demonstrate that the cost of insuring against such a shortfall always lowers at longer horizons. Van Eaton and Conover (1997) and Zou (1997) also use option-pricing theory to show that the cost of insuring against an equity return shortfall first lowers, before increasing at some longer horizon that depends on the (arbitrary) choice of the benchmark (minimum) rate of return.

Empirical examinations of shortfall risk measures in longer horizon portfolio allocation decisions blend intuitively appealing results with counterintuitive results. Ho, Milevsky & Robinson (1999) examine minimizing shortfall risk in equity portfolios, finding that diversifying Canadian investors equity portfolios to include U.S. equities lowers shortfall risk for equity investors, as intuition would suggest. Similarly, Vora and McGinnis (2000) withdraw funds from retirement portfolios with different mixes of equity and risk-free assets. Their findings challenge the conventional advice to hold a larger proportion of bonds as a retirement horizon shortens because consumption shortfalls can occur often in bond-heavy retirement portfolios and large windfalls can occur often in stock-heavy retirement portfolios. Ameriks, Veres, & Warshawsky (2001) examine sustainable withdrawal rates for rolling 20-, 30-, and 40-year retirement periods from "conservative," "balanced," "growth" and "aggressive" financial portfolios, ranging from 20% to 85% equities. Maximum withdrawal rates are dramatically worse for "conservative" portfolios versus the other three types of portfolios for 30- and 40-year retirement periods, but all were about the same for a 20-year retirement period.

To summarize, no theoretically consistent argument or empirical finding based on reduced equity risk at longer horizons supports the common practice of holding larger equity allocations of financial assets when horizons are longer and reducing the allocation as retirement approaches. We decided this warranted investigating alternative justifications for this practice.

## 3. Total wealth approach to portfolio allocation

Bodie, Merton & Samuelson (1992) describe the most sophisticated and complete model of an investor's asset allocation-over-time decision. They model decisions for investors who maximize lifetime expected utility of consumption considering: (1) savings versus consumption; (2) labor versus leisure; and (3) the consequent financial asset allocation between stocks and a less risky asset over time. Notably, their decision making model of an investor's wealth separates financial assets from human capital (the present value of future employment earnings). Reichenstein and Delaney (1995) use a total portfolio approach that includes an investor's home equity and mortgage liability in determining the appropriate asset allocation. Hanna and Chen (1997) include human capital in a total portfolio approach to the asset allocation decision.

Bodie et al. (1992) model two predictable life-cycle effects that give reasons to adjust investor equity allocations over different time horizons. One effect results from assuming investors are less able to alter their labor supply decisions as their anticipated retirement date approaches. Generally, more flexibility in deciding how much, and how long, investors can work allows them to tolerate more equity risk in their financial retirement accounts, leading to a greater equity allocation for workers with more flexibility. In other words, the more easily investors can work more hours, or work more years, to make up for unexpectedly poor investment results, the more equity risk they can bear. If, as the model assumes, such labor supply flexibility declines with age, it will be optimal to reduce the equity allocation as one ages. So we can justify the common advice given to investors using the reason that labor supply flexibility is reduced with increased age.

While reduced labor supply flexibility and its ensuing justification of larger equity allocations earlier in an investor's working life is clear; it may not be a compelling argument for many younger workers facing asset allocation decisions in financial asset retirement portfolios. Poor investment results, for example, could coincide with fewer opportunities to work more, as in the unappealing case of an extended recession at the time of retirement. Other problems with labor supply flexibility include: (1) inflexible retirement dates that prevent individuals from working longer; (2) postponing retirement is costly, in leisure terms, to the problem of adverse investment results; and (3) many individuals find that late-life employment wage rates are lower than prime earning years wage rates so their working years increase substantially, potentially never retiring.

The second, and more compelling, reason for an investor to reduce equity allocations over time in the Bodie et al. (1992) model rests on two model assumptions and two implications. The first assumption is that the investor's total retirement portfolio is made up of both financial assets and human capital (the present value of future employment earnings). The second assumption is that human capital is a less risky asset than equities. These assumptions, combined with the insight that the investor's total portfolio must have changing mixes of human capital versus financial assets over the course of a lifetime, yield an interesting reason for believing that equity allocations of the financial assets held in a retirement portfolio should change during a person's working life, predictably, based on an investor's risk tolerance, current wealth, and investment horizon.

The first implication of the model is straightforward. Early in an investor's working life, the greatest part of an investor's total portfolio wealth is human capital so financial assets in investment accounts are a relatively small proportion of their total portfolio wealth. Even a 100% allocation of retirement financial assets into equities contributes little risk to total portfolio wealth. Consequently, the total portfolio of financial and nonfinancial assets will have less risk than an investor targets, in the early years of investment for retirement, even for relatively risk-averse investors.

The second implication follows the total portfolio's wealth conversion process through a saver's life. Financial assets increase each year because human capital is converted (by working and saving income) to financial assets. If incremental income is entirely saved in the less risky financial asset, human capital is simply converted to financial, less risky, assets and total wealth does not change. However, if any annual savings are invested in equities, total wealth will increase, and the total wealth portfolio's equities proportion will increase through time. A 100% allocation of financial assets to equities, in the early years of an investor's working life, will increase the dollar value of past equity investments much more quickly as equity investments increase in value (investments in financial equities are assumed to grow more quickly than investments in financial risk-free securities). Both effects will increase the proportion of total portfolio wealth (including the present value of human capital) held in equities over time.

Consequently, for a given level of risk aversion, the investor may, at some horizon, find that the proportion of total wealth invested in equities is adequate, and begin to invest additional savings in less-risky financial assets. As retirement approaches, the investor's desired allocation of total wealth to equities may remain constant, but the proportion of the investor's financial assets in equities will decrease as human capital is converted through savings to financial assets. This total portfolio wealth reason justifies the common advice given to investors to lower their financial assets' equities proportions as the investor's time horizon shortens.

Fraser, Jennings & King (2000) examine a similar life-cycle problem as the problem posed here. Their study examines how to measure the present value of Social Security benefits in retirement portfolio asset allocations. Since Social Security benefits are considered to be risk-free assets, it further amplifies the tendency to hold high proportions of risky assets in the financial asset portion of a retirement portfolio early in life. Reichenstein (1998) argues that a retirement portfolio should include all financial assets, explicitly including after-tax Social Security benefits; the value of a house and other real assets; and should be offset by the value of a mortgage on real assets. Including or excluding either Social Security benefits, and other financial assets and liabilities, when defining retirement assets definitely changes the equity proportion of total retirement assets thus influencing the arguments reached in this analysis.

## 4. Reducing life-cycle model complexity to solve a practical problem

While Bodie et al. (1992) provide theoretically consistent justifications for investors to reduce equity allocations in retirement accounts as they move through their working years, applying the model to a specific financial planning problem is not so simple. Both the model's complexity and the difficult task of estimating the model's variables and investor-specific parameters make it virtually impossible to calculate the numerical effect of changes in the length of the investment horizon on a particular investor's optimal portfolio allocation.

To apply the Bodie et al. (1992) model to the problem of determining appropriate equity allocations in retirement accounts, we reduce its complexity in two ways. First, we assume that there is no labor supply flexibility (we cannot work harder late in life to make up for bad investment performance).

Second, we assume that an investor has only two assets: a single retirement account, and the present value of anticipated retirement plan contributions. This assumption pegs retirement plan contributions at a predetermined level, and allocates earnings above this amount to consumption, but preserves the important effects on asset allocation of the changing composition of total wealth over time. These two simplifying assumptions make it possible to determine how equity allocations in retirement accounts change over time as financial securities become a greater proportion of portfolio value. The model requires knowledge of the retirement saver's desired target equities allocation, time to maturity of the retirement portfolio, and projected earnings stream. While limiting, the model can still accommodate the Social Security asset modeled by Fraser, Jennings & King (2000) and the house, mortgage, and Social Security assets modeled by Reichenstein (1998). Likewise, defined benefit plans are similar to Social Security in this framework. Defined benefit plans are *modeled* differently if the defined benefit plan pays a constant monthly amount that does not increase with inflation, but are modeled the same if the annuity is inflation adjusted.

### *4.1. Model: problem of 40-year-old married couple with 60% equity target*

Suppose a couple contributes 10% of annual pretax earnings to their 401(k) or similar tax-deferred retirement account each year from now until retirement. Together they earn $40,000 per year; they have just begun saving, will receive wage increases of 3% each year (approximately constant real income), and plan to retire after 25 years. The couple desires 60% of their total assets in equities with the remainder in less-risky investments. In each year that the couple works, the value of their financial assets grows by earnings and by contributions (saving some of that year's income). During the previous 20 years of work, the couple has worked 40 quarters, thus qualifying them for Social Security, a riskless asset. They decide that this risk-free component of their total portfolio is unlikely to satisfy their desires, but its existence allows the couple to tolerate 60% of their total non-Social Security wealth as equities.

In any year, the couple's retirement portfolio sums the financial asset values of equities and less-risky assets and human capital, or the present value of *future* contributions. Human capital and the less-risky financial asset have equal risk. During the couple's working life, the proportion of human capital relative to financial assets must decline (from 100% human capital at the start of savings to 0% at retirement). Likewise, equities in the portfolio will increase (from 0% at the beginning of savings).

We assume that equities earn an average annual return of 12% and the less-risky asset earns an average of 7% per year. Table 1 illustrates the change of the value and composition of total retirement assets. "Remaining Years to Retirement" refers to the investment horizon at a particular time. The first column, "Annual Saving," shows the annual cash contributions to the retirement account (assumed to be made at year-end). The column labeled "Present Value of Future Contributions" is the present value of these anticipated retirement plan contributions, discounted at 7% per year. Interestingly, for the first four years of savings, the present value of future retirement plan contributions grows, even though there are fewer

Table 1
Retirement savings, future contributions and yearly equity allocations

| Remaining yr to retirement | Annual savings | Present value of future contributions | Financial assets | Financial to total assets | Equities to total retirement assets | Equities to financial assets | Age |
|---|---|---|---|---|---|---|---|
| 25 | $4,000 | $61,422 | $0 | 0% | 0% | 100% | 40 |
| 24 | $4,120 | $61,722 | $4,000 | 6% | 6% | 100% | 41 |
| 23 | $4,244 | $61,922 | $8,600 | 12% | 12% | 100% | 42 |
| 22 | $4,371 | $62,013 | $13,876 | 18% | 18% | 100% | 43 |
| 21 | $4,502 | $61,983 | $19,912 | 24% | 24% | 100% | 44 |
| 20 | $4,637 | $61,820 | $26,803 | 30% | 30% | 100% | 45 |
| 19 | $4,776 | $61,511 | $34,656 | 36% | 36% | 100% | 46 |
| 18 | $4,919 | $61,040 | $43,591 | 42% | 42% | 100% | 47 |
| 17 | $5,067 | $60,393 | $53,742 | 47% | 47% | 100% | 48 |
| 16 | $5,219 | $59,554 | $65,258 | 52% | 52% | 100% | 49 |
| 15 | $5,376 | $58,503 | $78,308 | 57% | 57% | 100% | 50 |
| 14 | $5,537 | $57,223 | $93,081 | 62% | 60% | 97% | 51 |
| 13 | $5,703 | $55,692 | $109,642 | 66% | 60% | 90% | 52 |
| 12 | $5,874 | $53,887 | $127,980 | 70% | 60% | 85% | 53 |
| 11 | $6,050 | $51,785 | $148,269 | 74% | 60% | 81% | 54 |
| 10 | $6,232 | $49,360 | $170,700 | 78% | 60% | 77% | 55 |
| 9 | $6,419 | $46,583 | $195,483 | 81% | 60% | 74% | 56 |
| 8 | $6,611 | $43,425 | $222,847 | 84% | 60% | 72% | 57 |
| 7 | $6,810 | $39,853 | $253,046 | 86% | 60% | 69% | 58 |
| 6 | $7,014 | $35,833 | $286,356 | 89% | 60% | 68% | 59 |
| 5 | $7,224 | $31,328 | $323,081 | 91% | 60% | 66% | 60 |
| 4 | $7,441 | $26,296 | $363,553 | 93% | 60% | 64% | 61 |
| 3 | $7,664 | $20,696 | $408,139 | 95% | 60% | 63% | 62 |
| 2 | $7,894 | $14,480 | $457,238 | 97% | 60% | 62% | 63 |
| 1 | $8,131 | $7,599 | $511,290 | 99% | 60% | 61% | 64 |

A couple saves 10% of annual real income each year from age 40 until retirement at age 65. Savings contributions occur at the end of the year to a financial asset retirement account. From the beginning, the couple's goal is to have 60% of their total portfolio wealth in equities. At age 40, 100% of their total portfolio wealth is in low-risk human capital, so the 60% cannot be attained. Through time, human capital is converted via savings into financial assets, which is composed of equities and less risky bonds. For example, the $8,600 of financial assets at beginning of "23 remaining years to retirement" equals $4,000 (1.12) + $4,120, where $4,000 is financial assets at the beginning of 24 years to retirement plus $4,120 at the end of the 24th year.

successive contributions to be made. Table 1 results are not sensitive to the interest rate choice as long as the less-risky interest rate is lower than the risky investment return. The 7% interest rate approximates the corporate bond interest rate rather than risk-free Treasury bill returns.

By assumption, equities allocations are targeted at 60% of total portfolio wealth (including the present value of expected future savings). The column labeled "Financial Assets" is the value of the financial securities in the retirement account, assuming a compounded annual growth rate of 12% for equities and 7% for the (less risky) alternative asset. Early in their working years, our couple has much less than 60% of their total portfolio wealth held as equities. The equity investment, as percentage of total wealth, is shown for each year, in the column labeled "Equities to Total Retirement Assets." As this value is less than the 60%

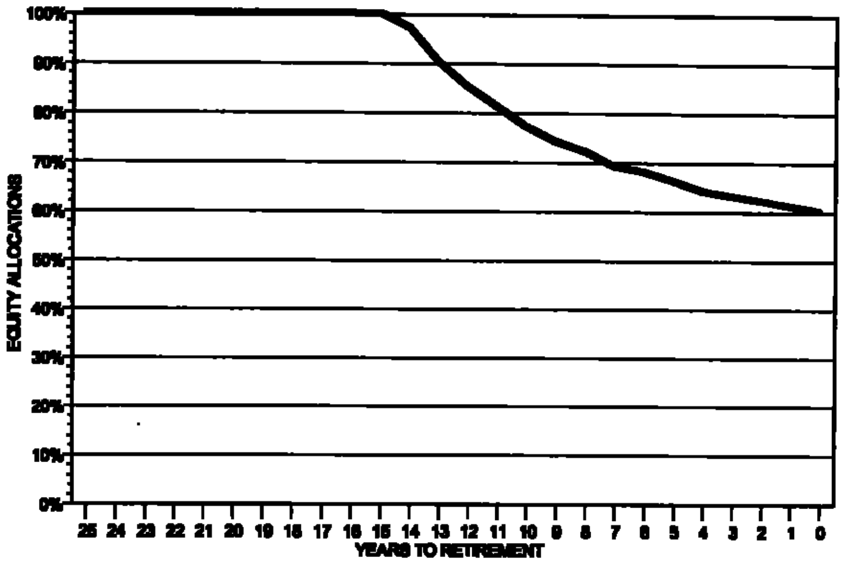


Fig. 1. Plots the annual preferred equity allocations as a percentage of financial assets for a couple that saves an equal, real $4,000 per year (10% of their income) towards a target allocation of 60% of their total portfolio of retirement assets. The equities allocation in financial assets starts at 100%, then declines to 60%, beginning in the 11th year of savings.

target allocation during the first 11 years, 100% of the retirement account's financial assets are invested in equities, as shown in the column "Equities to Financial Assets."

At age 51, 60% of total wealth is held as financial securities. At this point, with a 14-year investment horizon remaining, financial assets are 62% of total wealth (including the present value of future contributions). The percentage of the couple's retirement account invested in equities, resulting from a target allocation of 60% of their total wealth to equities, amounts to a 97% allocation of *financial* assets to equities. Naturally, the equities allocation percentage then drops each year until retirement to the 60% level. Fig. 1 shows the Table 1 retirement account equity allocations at each horizon.

### *4.2. Sensitivity to model assumptions*

Decreasing equity allocations over time in our example are not very sensitive to changes in either equity returns assumptions, the target equity allocation assumption, or the retirement account balance at the beginning of the 25-year planning horizon. Fig. 2 shows annual percentage allocations based on target equity allocations that are 50% and 70% of total wealth as well as the 60% base case. The pattern of equity allocations over time is quite similar to that of Fig. 1. Target equity allocation of 50% of total wealth shows the retirement account is 100% invested in equities for the first 9 of the couple's working years (Fig. 2). Target equity allocation of 70% of total wealth reveals the retirement account assets is 100% invested in equities for the first 13 years (Fig. 2).

Increasing retirement plan contributions at a faster rate or increasing the present value of

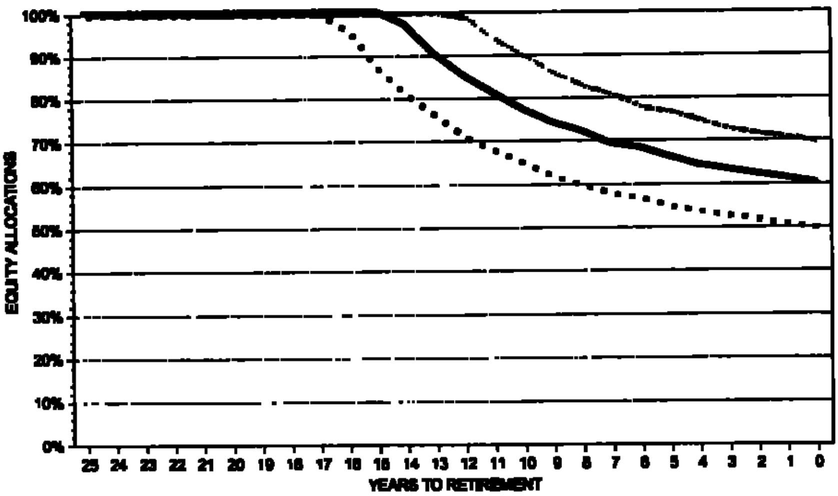


Fig. 2. Plots annual preferred equity allocations as a percentage of financial assets for a couple that saves an equal, real $4,000 per year (10% of their income) towards a target allocation of 50%, 60%, or 70% of their total portfolio of retirement assets. The bottom, dotted line is the 50% allocation, the center, solid line is the 60% allocation, and the top, dashed line is the 70% allocation.

future retirement account contributions results in the 100% equity allocation persisting longer than in the Fig. 1 example. Generally, *using either a higher (lower) discount rate in calculating the present value of future contributions or a higher (lower) assumed rate of return on equities will reduce (increase) the number of years that a 100% equity allocation in the retirement account is optimal.*

In the examples, we assume the household retirement account balance to be zero at the beginning of the planning period. With a beginning balance of $30,000 in the retirement account, Fig. 3 illustrates retirement account equity allocations for a target allocation of 60% of total wealth. The implied equity allocations fall below 100% in the 7$^{th}$ year, rather than the 11$^{th}$ year, and are below 70% for the last 10 years of the 25-year working/saving period. As expected, the couple's terminal wealth is much higher if they have an initial retirement fund balance rather than starting out with zero savings (retirement wealth increases to $856,310 rather than $511,290 because the couple invests the beginning balance of $30,000 for 25 years.)

Likewise, if we consider Social Security wealth, the couple's total retirement portfolio includes the present value of Social Security benefits, which share the risk level of human capital or the less risky financial asset. At an income level of a real $40,000 per year, Social Security benefits will be about $14,472 annually in today's dollars (from www.ssa.gov, the monthly benefit on an income of $3,333 per month ($40,000/12) is a primary insurance amount of 0.90($561) + 0.32($3,333-$561), or $1,391/month, or $14,472 annually). The average life expectancy is 23.9 years according to updated mortality tables from the Society of Actuaries (2000). The value of Social Security is the present value of a real $14,472 per year for 24 years beginning at age 65 when discounted at a 4% real rate (7% less 3% inflation rate). At age 65, Social Security is worth $220,654. At age 40, it is worth $82,771. This asset

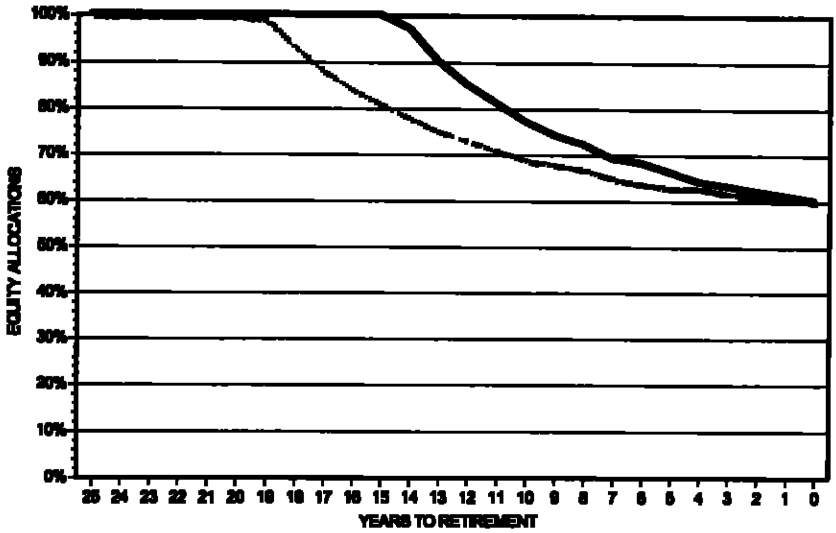


Fig. 3. Plots the annual preferred equity allocations as a percentage of financial assets for a couple that saves an equal, real $4,000 per year (10% of their income) towards a target allocation of 60% of their total portfolio of retirement assets with no beginning balance of savings. This line is plotted as the upper, solid line. Alternatively, assuming a $30,000 beginning balance shows that target financial assets equity allocations drop below 100% much sooner. The lower, dotted line shows the equities allocation for this second situation. Ending wealth differs, of course, with substantially more wealth for the couple that has the beginning balance.

cannot be converted to financial equity except through savings of income. The net effect of considering Social Security income in our example is to delay the first year in which financial assets drop below 100% allocation of equities. In our first example, instead of decreasing from 100% at age 51, the family would first decrease at age 59, since it had a 60% equities proportion of total wealth target. Social Security benefits increase the family's risk tolerance and lower their savings rate, both of which maintain 100% equity allocations in financial asset portfolio almost until retirement for this family. The same holds true for any other defined benefit pension plan.

## 5. Decreasing equity allocations: a historical perspective

The first way to ask whether anticipated future retirement plan contributions are important in determining optimal asset allocation strategies over time is: Should an advisor recommend a constant equity allocation strategy or a decreasing equity allocation strategy to investors who will make predictable future contributions to their retirement account? A second way to ask whether anticipated future retirement plan contributions are important in determining optimal asset allocation strategies over time is: Should an advisor recommend a constant equity allocation strategy or a decreasing equity allocation strategy to investors who will make no future contributions to their retirement account?

We examine both questions by comparing the historical results of a decreasing equity

Table 2
Ending wealth outcomes for overlapping 25-year holding periods from 1926–1996: single initial account contribution

| Strategy | Equity allocation | Mean ending account dollar value | Standard deviation of ending account dollar value |
|---|---|---|---|
| #1 | Constant 60% | $7.76 per $1 of Initial Wealth | $2.04 |
| #2 | Start at 72% and reduce by 1 percentage point per year | $7.75 per $1 of Initial Wealth | $2.08 |
| #3 | Start at 84% and reduce by 2 percentage points per year | $7.76 per $1 of Initial Wealth | $2.31 |
| #4 | Start at 95.8% and reduce by 3 percentage points per year | $7.76 per $1 of Initial Wealth | $2.65 |

This table compares four lump-sum asset allocation strategies. Each strategy begins with a $1 investment and we record the ending account values after 25-year periods. Each strategy allocates the investment between "Large Common Stocks" and "Treasury Bills." Strategy 1 begins with a 60% equity allocation and rebalances to 60% at the end of each year. Strategy 2 begins with a 72% equity allocation and rebalances to a consecutively 1% lower equity allocation each year. Strategies 3 and 4 have higher initial equity allocations but decrease the equity allocations by, respectively, 2% and 3% each year. We compare the mean and standard deviation of the ending account values after all 25-year periods between 1926 and 1996. We calculate results beginning each year from 1926 through 1971 (the last 25-year period ends in 1996) using annual returns data from Ibbotson Associates.

allocation strategy and a constant equity allocation strategy for a lump-sum investor and a periodic investor. We use the annual total returns of equities and Treasury bills from 1926 to 1996 to compare the effects of the two strategies on the account values at the end of 25-year holding periods. For each of the 25-year periods beginning in the years 1926 to 1971, we calculate the ending wealth, both for a single lump-sum initial investment, given in Table 2, and for annual contributions over the 25-year period, given in Table 3.

### 5.1. A lump-sum investor

Consider a 40-year-old investor saving for retirement, in a tax-deferred account, who has significant funds in the account, but who will not make any additional contributions. His results are summarized in Table 2. This investor uses a fixed-allocation strategy that adjusts the proportion of the account invested in equities to a particular level, at the end of each year. A second allocation strategy begins with a higher proportion invested in equities and reduces this proportion at the end of each year.

Using data from Ibbotson Associates (Stocks, Bonds, Bills, and Inflation, 1997 Yearbook), we calculate the ending value of an account that is invested in "Large Common Stocks" and "U.S. Treasury Bills," rebalancing the account, annually, according to each asset allocation strategy. The economic implications of the results reported here are unchanged if we use the returns on long-term Treasury bonds instead of Treasury bill returns.

Table 3
Ending wealth outcomes for overlapping 25-year holding periods from 1926–1996: equal annual account contributions

| Strategy | Equity allocation | Mean ending account dollar value | Standard deviation of ending account dollar value |
|---|---|---|---|
| #1 | 60% Constant | $93 per $1 of Contribution | $20.83 |
| #2 | Begin with 75% and reduce by 1 percentage point per year | $93 per $1 of Contribution | $19.17 |
| #3 | Begin with 90% and reduce by 2 percentage points per year | $93 per $1 of Contribution | $18.25 |
| #4 | Begin with 100% and reduce by 2.67 percentage points per year | $93 per $1 of Contribution | $18.16 |

This table compares four equal annual contribution asset allocation strategies that invest $25 of principal but trickles the investment into the account over time. Each strategy invests $1 on January 1 for 25 years, for beginning dates that start in 1926 to 1971. The $1 annual investment is divided between "Large Common Stocks" and "Treasury Bills" according to the strategy listed in column 2, using the Ibbotson Associates annual returns data. A total principal investment of $25 is made during each of these strategies, but each maturity value will be different.

Strategy #1 is our base strategy, with a 60% static allocation of each $1 principal contribution to equities and the remainder to debt. The net effect of having a high initial allocation and dropping it over time is compared to strategy #1 by lowering the annual allocation to equities by a fixed percentage in each of the 24 following years. For example, the initial allocation of Strategy #2 equals 75% instead of the 60% in Strategy #1. Because Strategy #1 generates a mean result of $93 per $1 of annual contribution, we lower additional contribution allocation proportions by 1% per year, from 75% in strategy #2, to equal the mean result of strategy #1. In Strategy #3 and #4, we lower equity allocations faster as initial equity allocations are higher. The mean and standard deviation of the 46 outcomes from the 25-year investments are given in columns 2 and 3.

Table 2 shows the summary statistics for the results of the various strategies for the 46 overlapping 25-year periods beginning in each year from 1926 to 1971. "Mean Ending Dollar Account Value" is the average dollar amount in the account per dollar of initial investment after 25 years, ending in 1951 to 1996. The standard deviation of the sample results measures the risk, or uncertainty, about the account value at retirement over the 25-year holding periods.

The results in Table 2 indicate that an investor with a single sum to invest for retirement gains no advantage by reducing equity allocations in the account over time as retirement approaches. A strategy of rebalancing the account to a 60% equity allocation each year (Strategy #1) yielded a mean ending value of $7.76 (per dollar of initial investment). The standard deviation of the ending values under Strategy #1 is $2.04 (per dollar of initial investment).

Because a decreasing equity allocation strategy that begins with a 60% allocation to equities will produce lower ending values *and* less variation in these values, we must increase the beginning equity allocation to construct a comparable decreasing equity allocation strategy. For a decrease of 1% per year in the equity allocation, a beginning equity allocation of 72% (decreasing to 48%) produces an equivalent mean ending account value. The ending values for this strategy (Strategy #2) have a slightly higher standard deviation ($2.08) than the fixed-allocation strategy.

Results for two other comparable strategies are also reported in Table 2. Strategy #3 has a beginning equity allocation of 84% that is decreased by 2% per year, and Strategy #4 is to decrease the equity allocation from 95.8% to 23.8% over the 25-year investment horizon at the rate of 3% per year. Strategy #3 ending values have a standard deviation of $2.31, and those of Strategy #4 have a standard deviation of $2.65.

By construction, all four strategies produce virtually the same mean ending account value. However, the standard deviation of the ending values increases with faster decreases in equity allocation rates. If the variance of the value of the account at retirement reflects increased uncertainty, the decreasing equity allocation strategies produce less desirable results than constant allocation strategies. For a lump-sum investor, the conventional wisdom of decreasing equity allocations over time as retirement approaches is, in fact, not wise. The results clearly show that a decreasing equity allocation strategy makes more uncertainty for lump-sum investors.

### 5.2. *A periodic investor (similar to dollar cost averaging, but look carefully)*

Assuming that the investor creates equal contributions each year to the retirement account, the results are quite different. Table 3 shows the mean ending account values and standard deviations of these values per dollar of annual account contribution. Strategy #1 is still a fixed-allocation strategy, with 60% of the account's assets invested in equities each year and the remainder invested in T-bills. The mean ending account value is $93 and the standard deviation is $20.83.

Strategy #2 (which is constructed to produce a similar ending value) is to allocate 75% to equities in the first period and to decrease the equity allocation by 1% per year over the 25-year period. The standard deviation of the ending account values under this strategy is $19.17.

Strategy #3 begins with a 90% equity allocation that is decreased at the rate of 2% per year, and Strategy #4 has an initial equity allocation of 100% decreased at the rate of 2.67% per year. Each strategy is constructed to produce an approximately equal average ending account value. The standard deviation of the ending account values is $18.25 for Strategy #3 and $18.16 for Strategy #4.

Table 3 results for a periodic investor illustrate two points by comparison to Table 2's lump-sum investor. First, a periodic investor with a fixed-allocation strategy of 60% equities faces less uncertainty about the ending account value than a lump-sum investor. A lump sum of $12 invested at the beginning of the 25-year periods produces a mean ending account value of $93, as does an annual contribution of $1 under Strategy #1 (based on Table 2 results). The ending account standard deviation for the lump-sum investor is $24.51 ($2.0423 times 12), which is 18% greater than the standard deviation of the Strategy #1 ending account values for a periodic investor ($20.83 from Table 3).

Further, the worst outcomes for the 46 different beginning dates are $59.11 for the Strategy #1 periodic investor and, much worse, $37.02 for a Strategy #1 lump-sum investor. An identical asset allocation strategy produces much greater risk for a lump-sum investor than for an investor who will make periodic contributions to the retirement account. At least part of these results are time-period specific, because of the bull market that began in 1982 and its influence on the 15 25-year time periods that end between 1982 and 1996. Similarly, the 1973 to 1974 bear market had an enormous influence on the ending date payoff profile for the 25 25-year retirement portfolios that end on or span those dates.

Additional results support other implications of the total portfolio approach. When annual contributions are assumed to grow over time, the uncertainty (percentage standard deviation) about the ending account balance decreases, with larger decreases in risk for higher assumed growth rates. When the investor is assumed to have an accumulated balance in the account at the beginning of the 25-year period, risk is increased. This is because the results combine the characteristics of both the lump sum and periodic contribution strategies.

To summarize the conclusions from Tables 2 and 3, our examples reveal that:

1. Retirement investors making periodic contributions face less risk, for a given equity allocation, than those with a single lump sum to invest.

2. Investors increasing future contributions to the retirement account at a faster rate face less risk still for a given equity allocation.

3. Reducing equity allocations over time can diminish risk for investors who make periodic contributions to a retirement account, but likely will not for those with only a lump sum to invest.

## 6. Total portfolio approach discussion

The total portfolio approach to asset allocation has important practical implications for financial planners. Both current theory and the historical evidence indicate that expected future savings and investment have an important influence in determining the appropriate asset allocation strategy for individual investors. Conventional wisdom and rules of thumb are not adequate in all situations. A simple rule such as setting the equity allocation to a percentage equal to 100 minus the investor's age can turn out to be poor advice for both lump sum and periodic investors.

Assume now two groups of investors of the same age but different circumstances. At one extreme may be a group of recently tenured professors, who will receive cost of living increases in their salaries and who have very little uncertainty about both continued employment or retirement dates, but each professor possesses substantial different equity risk tolerance. The amount and the number of future retirement plan contributions are fairly certain. At the other extreme may be a group of professional athletes or entertainers who have accumulated significant savings for retirement, but are quite uncertain of how much each will earn and contribute to the account over their remaining working years, and each one possesses substantial different equity risk tolerance. The relative importance of future retirement plan contributions and present savings is quite different for the two pools, and their equity allocation retirement plan strategies over time should differ as well.

Most investors will likely fall between these two extremes. The central point is that the benefit of pursuing a strategy of large equity allocations when retirement is distant, and reducing the allocation as retirement approaches, depends on the relative importance of current retirement assets versus future contributions. This, in turn, may depend on the expected growth rate of retirement contributions over time.

The total portfolio approach to the asset allocation decision suggests that equity allocations should be relatively (and absolutely) large in the early years of retirement saving, when retirement account balances are likely to be small compared to the present value of future contributions, as would be the case for the professors. Consequently, the pool of professors can be given similar advice for the first few years of savings, as their income streams should be similar.

The total portfolio approach advice is true under a variety of scenarios concerning future employment and account contributions. A 65% equity allocation is 100 minus age for a 35-year-old retirement saver, but if this investor has just begun saving for retirement, such an allocation could represent an equity allocation of only 3% or 4% of total retirement wealth, including the present value of anticipated future retirement plan contributions. Consequently, the rule of thumb might be inappropriate advice for the pool of professors in general.

Turning our attention to the pool of entertainers or athletes with substantial savings early in life, we find that the rule of thumb of decreasing equities allocation for lump sum investors doesn't work very well historically, compared to a static asset allocation that is rebalanced (examples given in Table 3), using a total portfolio approach.

This analysis addresses only the factors to be considered for an investor who wants a sound life-cycle-based recommendation for a retirement portfolio allocation plan, and is willing to stick with the plan. The examples can be used to educate investors about the principles involved in the asset allocation decision so that the finance professional can help them to choose and follow a disciplined and rational investment strategy appropriate to their individual circumstances. Although we do not examine investor risk aversion, investor preconceptions, or any investor's or financial consultant's concerns about how annual fluctuations in account value will affect the investor's willingness to follow the plan, we are aware of these limitations of this analysis and recognize them as valid obstacles to implementing these recommendations for specific investors.

## 7. Conclusions for personal financial management

We offer an alternative explanation, separate from any change in equity risk, of the common advice to hold large equity allocations early in life and to reduce them as retirement approaches. We simplified the Bodie, Merton & Samuelson (1992) model, which includes total wealth, rather than just financial securities, in determining appropriate equity allocations. The effect of future retirement account contributions on uncertainty about wealth at retirement clarifies why many retirement savers should hold larger equity allocations early in their working years, then reduce their equity proportions after some significant period of years.

This perspective shows that it is not an increase in the risk of equity returns at shorter horizons that justifies a reducing equity allocation strategy. Instead, holding periods have different effects, depending on individual financial circumstances and savings. Interestingly, life-cycle models imply that most equity allocations in financial asset retirement accounts should be at or near 100% in the earliest years of retirement saving for a broad cross-section of investors. However, after the financial component of retirement savings increases, compared to the value of anticipated future contributions; the equity proportion should be reduced toward the investor's risk tolerance target proportion of total wealth.

In summary, the total portfolio retirement asset allocation perspective is:

1. Given a financial asset equity allocation in a retirement portfolio, larger future contributions reduce the immediate risk of the financial asset account's value by reducing uncertainty.
2. Strategies seeking to reduce risk by decreasing equity allocations over time have their greatest value when future contributions represent a large portion of total retirement assets.
3. Strategies seeking to reduce risk by decreasing equity allocations over time are least valuable (or possibly ineffective) when no future contributions will be made.
4. Lower expected growth rates of future contributions lowers their relative importance in risk reduction and in justifying decreasing equity allocations over time.
5. Greater uncertainty about the amounts and timing of future contributions also lowers their relative importance in risk reduction and in justifying decreasing equity allocations over time.

## References


Ameriks, J., Veres, R., & Warshawsky, M. J. (2001). Making retirement income last a lifetime. *Journal of Financial Planning, 14* (12), 60–74.

Bodie, Z. (1995). On the risks of stock in the long run. *Financial Analysts Journal, 51* (3), 18–22.

Bodie, Z., Merton, R., & Samuelson, W. (1992). Labor supply flexibility and portfolio choice in a life-cycle model. *Journal of Economic Dynamics and Control, 16* (3/4), 427–449.

Connelly, T. (1996). The time diversification controversy. *Journal of Financial Planning, 9* (1), 20–23.

Fraser, S. P., Jennings, W. W. & King, D. R. (2000). Strategic asset allocation for individual investors: The impact of the present value of Social Security benefits. *Financial Services Review, 9* (4), 295–326.

Hanna, S., & Chen, P. (1997). Subjective and objective risk tolerance: Implications for optimal portfolios. *Financial Counseling and Planning, 8* (2), 17–26.

Ho, K., Milevsky, M. A., & Robinson, C. (1999). International equity diversification and shortfall risk. *Financial Services Review, 8* (1), 11–25.

Kritzman, M. (1994). What practitioners need to know . . . about time diversification. *Financial Analysts Journal, 50* (1), 14–18.

Reichenstein, W. (1998). Calculating a family's asset mix. *Financial Services Review, 7* (3), 195–206.

Reichenstein, W., & Delaney, C. (1995). Portfolio management: An alternative approach to asset allocation. *Journal of Investing* (Fall), 57–62.

Samuelson, P. (1990). Asset allocation could be dangerous to your health: Pitfalls in across-time diversification. *Journal of Portfolio Management, 16* (3), 5–9.

Samuelson, P. (1989). The judgment of economic science on rational portfolio management: Indexing, timing, and long-horizon effects. *Journal of Portfolio Management, 16* (1), 4.

Society for Actuaries. (2000). Table 4–5 Male R. P-2000 Rates for 'Combined Healthy' and Table 4–6 Female R. P-2000 Rates for 'Combined Healthy' at www.soa.org/research.

Van Eaton, R. D., & Conover, J. (1997). Put prices and P.E.N. participation rates at longer horizons: Is equity risk in the eye of the beholder? *Financial Analysts Journal*, 53 (6), 66–72.

Vora, P. P., & McGinnis, J. D. (2000). The asset allocation decision in retirement: Lessons from dollar-cost averaging. *Financial Services Review, 9* (1), 47–63.

Zou, L. (1997). Investments with downside insurance and the issue of time diversification. *Financial Analysts Journal*, 53 (4), 73–79.