1-1-2001

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Published version. *Financial Services Review*, Vol. 9, No. 4 (2001): 295-326. DOI.

NORTH-HOLLAND

Financial Services Review 9 (2000) 295–326

FINANCIAL SERVICES REVIEW

Strategic asset allocation for individual investors: the impact of the present value of Social Security benefits

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Received 17 January 2001; received in revised form 1 March 2001; accepted 3 April 2001

Abstract

This paper demonstrates the dramatic effect of Social Security wealth on individuals' asset allocation. We first discuss why Social Security wealth should be included in portfolio asset-mix decisions. We then draw parallels between Social Security benefits and inflation-indexed treasury bonds to help quantify the present value of Social Security benefits. Finally, we show the portfolio impact of including Social Security wealth under several asset-mix decision rules. Excluding Social Security wealth from the asset mix decision results in suboptimal portfolios. Including Social Security wealth provides an incentive for including more stock in the asset mix. © 2001 Elsevier Science Inc. All rights reserved.

JEL classification: G11; H55; J26; J17; K13

Keywords: Social security; Portfolio choice; Mean-variance optimization; Valuation

1. Introduction

The question of retirement income adequacy is a matter of national concern given an aging population and the imminent baby-boomer retirement. Although defined contribution plans

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PII: S1057-0810(01)00072-5

have overtaken traditional pensions, one defined benefit plan—Social Security—affects virtually everyone. Only a limited group of workers is excluded from Social Security. Thus, comprehensive retirement planning should consider Social Security benefits. A typical financial planning approach deducts Social Security payments from a retirement income-needs amount to compute a retirement income gap that investments must fund. However, this income-adequacy approach ignores the effect of Social Security on portfolio asset-mix decisions. This is an inconsistency—if income-adequacy computations include Social Security, strategic asset allocation should also incorporate Social Security.

A fundamental aspect of financial planning is ensuring there is adequate retirement income. One means of doing so is to maximize the utility of one's retirement benefits—including Social Security. To that end, we consider three questions: First, should investors consider Social Security when making asset mix decisions? Second, how should an investor determine the value of Social Security benefits? Third, how does proper valuation of Social Security affect the asset mix of a financial portfolio? We address these questions in separate sections below.

Scott (1995, 1997), Reichenstein (1998, 2000) and others advance a concept we label an individual's "total portfolio." This total portfolio includes the traditional financial portfolio (stocks, bonds, cash, etc.) but adds other relevant assets. Scott and Reichenstein both argue that total portfolios should include the present value of Social Security benefits (which we call "Social Security wealth"). Few would argue that Social Security is unimportant, but even the financially sophisticated regularly exclude Social Security wealth from portfolio analysis. As an example, two popular financial planning textbooks (Gitman & Joehnk, 1999, and Kapoor, Dlabay & Hughes, 1999) acknowledge that Social Security reduces, to a degree, the need for other retirement income but ignore Social Security wealth's impact on portfolio composition. We take Scott's and Reichenstein's valuable insights and advance them with a detailed analysis of how to measure and include Social Security as a portfolio asset.

Despite the exclusion of Social Security from formal portfolio analysis, many people implicitly include Social Security as a portfolio asset as a matter of practice. Feldstein (1974) shows "Social Security substantially depresses personal savings." If Social Security empirically substitutes for savings, then the typical Social Security beneficiary is implicitly incorporating benefits in his or her portfolio. Hubbard (1985) shows that Social Security wealth affects both an individual's choice to include particular investments and their subsequent portfolio weighting. Individuals are inherently including Social Security in the asset mix decision, and portfolio analysis literature should include Social Security as well.

To address this issue, we first quantify the present value of Social Security benefits. We use the similarities between inflation-indexed treasury bonds and Social Security benefits to value those benefits. Both Social Security and Treasury Inflation Protection Securities (TIPS) have cash flows linked to the Consumer Price Index (CPI), and both are federal obligations. While there is slight ambiguity in the TIPS-Social Security analogy (which we discuss in section 3.2 below), TIPS are good approximations for Social Security wealth. With this wealth value computed, we investigate the effect of Social Security benefits on strategic asset allocation under several common asset-mix decision rules.

There are numerous approaches to the asset allocation decision ranging from the simple to complex. We consider simple fixed mixes, life-cycle rules and consensus expert views. In each case, the impact on an individual's asset allocation of including Social Security wealth is dramatic. Beyond these simple diversified portfolio approaches, we assess the impact of Social Security under mean-variance optimization. Social security benefits shift the mean-variance efficient frontier and offer substantial risk-reduction opportunities. Since Social Security wealth behaves much like an inflation-indexed treasury bond, considering it in the total portfolio has a striking impact on the optimized financial portfolio.

By answering the three questions (should we include Social Security? what is its value? and what is its impact?), we create arguments for adding stock to the asset mix. Siegel (1998) and others prescribe higher stock allocations than typical asset allocation models because of their long-run risk-return benefits. For some investors, investing in bonds can be comforting. Perhaps this is the case because their predictable cash flow allows them to plan their spending or because bond's stable returns can be reassuring. The notion that Social Security payments are very similar to treasury bond coupon payments is simple, intuitive, and persuasive—once the similarity is considered. To the extent it is persuasive, this analysis encourages increased stockholdings to achieve target asset allocations.

We organize the remainder of this paper as follows: Section 2 discusses the inclusion of Social Security wealth in an investor's portfolio. Section 3 presents our arguments for using TIPS to value Social Security as well as our specific valuation method and the underlying assumptions. Section 4 shows the asset allocation implications of valuing Social Security wealth. Section 5 summarizes our findings, discusses extensions and includes a simple one-paragraph description of how to apply our findings.

2. Social Security wealth as a portfolio asset

Despite widespread analysis of optimal portfolio asset allocation policy, there is little consensus on which assets to include. Given the dominance of strategic asset allocation decisions over security selection and market timing decisions (Brinson, Hood & Beebower, 1986), there is a critical need for accuracy in determining the portfolio. Reichenstein (1998, 2000) reviews and analyzes the inclusion and valuation of portfolio assets. He advances and enhances the Scott (1995, 1997) view of an "investment portfolio"; that is, assets that generate spending money or that can be sold for spending money. The "investment portfolio" is larger than a pure financial portfolio. Scott and Reichenstein both consider Social Security wealth a portfolio asset.

Beyond the limited individual finance literature, there is legal economics research on the value of retirement benefits (e.g., Stoller, 1992; Rosenman & Fort, 1992). Valuation is relevant to divorce, personal injury and wrongful death cases. Stoller notes, "The present value of a spouse's pension can easily be the most valuable asset that a couple possesses." As a valuable asset and as the most-portable pension, Social Security wealth should affect portfolio analysis as well.

Social security is a savings program in some respects. Foregoing consumption now in order to consume later is a prime reason for saving. Similarly, Social Security reallocates consumption across time (albeit *via* forced intergenerational transfers). This similarity supports thinking of Social Security wealth—like other savings—as a portfolio component.

Inflation offers another argument for including Social Security in the portfolio. Inflation is a big risk to retirees since they have limited opportunities to save more, work longer or work harder after an inflationary period. The inflation protection inherent in Social Security has historically been a wealth protector (Dalio & Bernstein, 1999). To the extent that portfolios exist for future consumption, Social Security's inflation protection suggests it be considered part of the portfolio.

Counterarguments to including Social Security wealth also exist; one is simplicity. The value of Social Security benefits relies on many hard-to-estimate variables. However, simply ignoring Social Security wealth can hurt portfolio efficiency. Another counterargument is pessimism. Planning for the worst can lead to the pleasant condition of having greater retirement wealth than required. This approach appeals to the risk averse. However, the pessimistic approach ignores the economic reality that a suboptimal risk-return tradeoff is a disservice to even the most risk-averse.

The most pessimistic view of Social Security is that the system will fail before an individual retires. In response, there are several proposals for Social Security reform including those that incorporate elements of privatization. If that were to occur, the system would include asset accounts that could hold stocks and bonds. Even partially privatized Social Security has clear portfolio implications. Alternative reforms that are more needs-based behave like portfolio insurance. If a reformed Social Security system has portfolio management implications, then the current Social Security should be included in portfolios as well.

3. Valuation

To be included in a portfolio, Social Security wealth must be valued. To value Social Security wealth, we first discuss the nature of Social Security benefits. We then consider our market-based proxy for Social Security cash flows—inflation-indexed treasury bonds—and draw parallels between the two. Finally, we undertake the actual valuation.

3.1. Social Security benefits

The Social Security Act encompasses numerous social insurance programs. This paper focuses only on its retirement aspects. For simplicity, we ignore other aspects of the Act including nonspouse survivor benefits, disability insurance, death benefits, Medicare, unemployment insurance, black lung benefits and Supplemental Security Income. Within the retirement aspects, we consider only the old age and survivors insurance (OASI) program—and then only the wage earner retirement, spousal retirement and widow(er) retirement benefits. Our approach is conservative; considering other Social Security benefits would increase the value of Social Security benefits and amplify any impact of Social Security wealth on asset allocation.

Social security retirement benefits are available to retired insured workers age 62 and over, the spouse (age 62 and over) of retired insured workers and the surviving spouse (age 60 and over) of a deceased insured worker. Almost everyone in these age groups is included—Social Security excludes only pre-1984 federal workers, some state employees, election officials, railroad employees, student nurses, paperboys and girls, clergy who opt out, and members of certain religious sects like the Old Order Amish. A worker becomes fully insured after 40 quarters of earning a minimal amount (indexed to $3,120 annually in 2000). Full retirement age was 65, but began rising in 2000 and will reach age 67 in 2020. (Full retirement age is based on year of birth; details are in Thomas (1999, p. 76).) Reduced retirement benefits are, and will continue to be, available at age 62. Such reduced benefits were 80% of the primary insurance amount (PIA) in 1999 and gradually decline to 70% when the full retirement age is 67. If an individual continues to work past full retirement age, Social Security benefits increase. A piecewise linear function of the Average Indexed Monthly Earnings (AIME) credited to a worker's account determines the PIA benefit amount. In 2000, the PIA consists of 90% of the first $531 of AIME, 32% of the next $2,671 of AIME and 15% of AIME above that. AIME adjusts a worker's historical wages for average wage inflation. The maximum earnings credited to an account is the maximum amount subject to Social Security tax (indexed to $76,200 in 2000), so earning more than that maximum does not increase benefits. The maximum monthly PIA a worker may receive is $1,433 in 2000. Spouses of insured workers are entitled to the greater of their own PIA or one-half of the worker's PIA. A widow(er) past full retirement age is entitled to 100% of the worker's PIA although reductions similar to those for early retirement are available after age 60.

Social security benefits may be subject to income tax. If Social Security is the only source of income, benefits are generally tax-exempt. If annual taxable income for 2000 (including tax-exempt interest) is greater than $34,000 if single or $44,000 if married, 85% of the benefits are taxable. All Social Security benefits can be lost if the recipient keeps working and has annual wage income above certain thresholds (e.g., $10,080 if under full retirement age). Note that the Senior Citizens' Freedom to Work Act of 2000 only eliminated the Retirement Earnings Test for individuals aged 65–69. Additionally, Social Security benefits are effectively lost if the worker's other pensions are coordinated with Social Security (as with the Federal Employee's Retirement System and some private pensions). Thomas (1999) provides additional detail about Social Security.

3.2. Inflation-indexed treasury securities

We use treasury securities as our market-based proxy for valuing Social Security wealth. Treasury securities, and specifically Treasury Inflation Protection Securities (TIPS), are appropriate for two reasons. First, both Social Security and TIPS are senior federal obligations effectively backed by the full faith and credit of the government. Second, TIPS are appropriate because they distribute cash flows indexed to inflation (i.e., that are constant real payments). Although the future of Social Security is the subject of much speculation, it can be valued with sufficient detail for our analysis. Using TIPS allows us to quantify the rate of return on inflation-indexed federal obligations; today's TIPS real yield is appropriate for discounting the projected constant real Social Security benefit payments.

TIPS, like Social Security, have unknown nominal cash flows but predictable real cash flows. Both instruments include embedded protection against changes in inflation—a feature that ordinary bonds omit. TIPS are bonds and notes with semiannual interest payments based on a fixed coupon rate. However, the underlying principal amount adjusts for inflation, and the coupon payment is calculated based on the inflation-adjusted principal amount.

Using TIPS yields to quantify values of real federal obligations requires acknowledging some caveats. First, cash flows from TIPS and Social Security depend on different versions of CPI. TIPS measure inflation with the Consumer Price Index for Urban Consumers; Social Security benefits increase with the Consumer Price Index for Urban Wage Earners and Clerical Workers (Phoa, 1999; Thomas, 1999). However, the two CPIs are highly correlated ($>$0.99) and almost identical in magnitude, so this difference is inconsequential. Second, TIPS adjust for inflation daily and use a nonseasonally adjusted CPI. Within a year, TIPS inflation accrual can vary dramatically and affect yields (Kan, 1999). Since Social Security does not rely on seasonal adjustments, using TIPS yields—with their seasonalities—can lead to slight mispricing. In our valuation, the impact is negligible. Seasonal adjustments are greatest November-March; however, Kan (1999) shows the average seasonal/nonseasonal difference is only one basis point in June, our valuation month.

Another caveat involves taxes. All coupon payments on TIPS are federally taxable, but, at most, 85% of Social Security payments are taxable. This difference is economically insignificant for this analysis. It has less than 3% impact on our valuation of Social Security benefits, so we ignore this difference. However, TIPS incur an additional tax on the CPI-driven increase in principal amount. Each year, as the principal value increases with inflation, the increase is taxable at the ordinary income tax rate. There is no similar tax on the increase in future Social Security benefits. This has three consequences for our analysis. First, TIPS yield may be higher if investors are compensated for this tax. If the yield is higher, then using TIPS undervalues Social Security wealth. Adjusting for this difference would only heighten the portfolio impact of including Social Security as a portfolio asset. Second, TIPS interest is exempt from state income tax. Social security benefits are not necessarily exempt, but many states do have significant exemptions or deductions for pension income. Third, this taxation substantially limits the advantages of inflation-indexed bonds for (taxable) individuals under mean-variance optimization (Kinney, 1999) but does not affect Social Security similarly.

A final caveat to the TIPS proxy for Social Security concerns duration. TIPS and Social Security with the same maturity (i.e., bond maturity equal to life expectancy) have different sensitivities to interest rate changes as measured by Macaulay duration because TIPS have a large terminal cash flow and Social Security does not. Because we focus on point estimates of Social Security wealth, we ignore the duration issue. We can safely do so because duration has minimal consequences on TIPS pricing. The TIPS yield curve is quite flat; bonds with different coupons but similar maturity have similar real yields (as of June 2000).

3.3. Valuation detail

Assets are worth the present value of expected future cash flows. We have major valuation components described (i.e., Social Security benefits described and a good discount rate proxy) but must make a few more assumptions. Valuing pensions requires estimates about coverage levels, work life, job tenure, age, mortality, discount rates, taxation, salary increases and inflation. This present value approach is the micro equivalent of macrovaluations of gross national Social Security wealth in the literature (Feldstein, 1974).

Even the micro approach is not novel. Reichenstein (1998, 2000) argues for including the present value of Social Security benefits in asset mix decisions, but does not quantify it because of Social Security's complexities. Scott (1995) argues for inclusion of Social Security wealth as a fixed income component of the total portfolio, but in discussing pensions is ambiguous in her prescription. First, she relates Social Security to defined benefit pension plans, but there suggests incorporating the value of *current* payments. Second, she argues for excluding distant and uncertain cash flows. One interpretation of these two points is that Social Security is a portfolio asset only for retirees. Third, she offers limited guidance in selecting a discount rate. Her pension example uses nominal treasury yields, but this ignores Social Security's inflation adjustment as well as risk adjustments (e.g., default risk in her corporate pension). We build on Reichenstein's (1998, 2000) and Scott's (1995) valuable insights.

Before going into details, we should clarify the appropriate valuation framework. Social security wealth is not liquid, that is, it cannot be sold or explicitly be used as collateral. Lack of marketability affects value. This is the essence of the valuation framework that applies a marketability discount to value an illiquid asset. Since the marketability discount increases with the difficulty of selling an asset, the "fair market value" of Social Security wealth under this paradigm is zero. (Note, however, that if Social Security wealth could be sold, its near-certain cash flows would minimize any marketability discount (see Pratt, Reilly & Schweihs, 1996, p. 358).) Rather than fair market value, the individual-specific valuation is relevant to an individual's asset allocation decision. This is investment value, or "value to a particular investor based on individual investment requirements" (Pratt et al., 1996). Using investment value is valid because even nonsalable assets have individual-specific value.

We describe our specific methodology and assumptions in the subsections below. In turn, we discuss the timing of Social Security cash flows, the size of Social Security cash flows, discounting the cash flows and our valuation results.

3.3.1. Timing of cash flows

Several cash flow timing issues are relevant to our valuation. We discuss retirement timing, age and mortality in the following paragraphs.

Social security includes a retirement-timing option. Reduced benefits are available 3–5 years before the statutory full retirement ages of 65–67. We focus our primary analysis on those who take or took Social Security at age 62 (but consider age 65 in the Appendix). We do this for two reasons: First, Detweiler (1999) evaluates the early retirement decision; he calculates present values and concludes that retired men should start Social Security at age 62 when real returns are more than 2.25% and that retired women should do so for real returns above 4.5%. Second and more importantly, most people start benefits at 62 (Congress, 1996).

We calculate the present value of Social Security benefits for a wide range of ages as of 2000. This date is relevant since we incorporate the planned increases in statutory "full retirement" ages. That is, the present value reflects the early retirement penalty, which varies according to birth year (Thomas, 1999). We assume spouses are the same ages (but consider alternatives in the Appendix).

We use IRS life expectancy tables (IRS publication 939, 1997), which force two simplifying assumptions. First, the primary IRS tables do not distinguish between men and women—death does. Second, we ignore the correlation between health and wealth (Smith & Kington, 1997). The high earner we evaluate below is more likely to have the resources to pay for quality health care and nutrition (Evensky, 1997).

3.3.2. Size of cash flows

In our valuation, we focus on high-income individuals. We do so without much loss of generality. Social security benefits are increasing in earned income; further, savings are likely increasing in income. That is, both Social Security wealth and financial portfolio value are likely correlated with earnings. Although the exact quantities will differ, *qualitative* conclusions drawn from high earners are relevant across most income classes. In support of this view, we consider a lower-income case in the Appendix.

We assume our worker earns $76,200 in 2000—the maximum amount credited to a Social Security account. We assume the worker earns the inflation-adjusted equivalent of $76,200 in all years before retirement. This has several consequences. First, if earned in the top-earning thirty-five years of working lifetime, this qualifies for maximum retirement benefits. Recall that maximum monthly benefits are $1,433 in 2000. We assume retirees qualify for this maximum PIA. Second, this means the worker never receives any real wage increases. Third, we use this earnings stream to compute financial portfolio values when we discuss asset allocation implications. As we detail there, these last two consequences are conservative—they reduce Social Security's impact on portfolios.

Recall that income earned (above certain thresholds) while receiving Social Security reduces benefits. We avoid this complication by assuming the worker truly retires at 62 and has no *earned* income. (*How Work Affects Your Benefits,* a Social Security Administration publication (2000), says, "we do not count nonwork income such as investment earnings, interest, pensions, annuities, capital gains, and other government benefits" for this earnings test.) We assume the high-earner retiree receives sufficient unearned income from other sources to force the maximum 85% taxation of Social Security benefits. That is, the retiree's annual income from all sources exceeds $34,000 if single or $44,000 if married. This assumption makes Social Security benefits very similar to other income with respect to taxes and forces a lower value of Social Security benefits. If a retiree had lower income from other sources, this would shield some Social Security benefits from taxes. This higher tax shield would necessitate decreasing the discount rate on Social Security benefits to keep it equivalent to taxable TIPS yields; such a lower discount rate would increase the value of Social Security wealth. Lower Social Security values are conservative with respect to our conclusion that Social Security has dramatic portfolio implications. We compute the present value of these cash flows—on a pretax basis. This pretax basis allows direct comparability of Social Security wealth to other portfolio assets. While Reichenstein (1998, 2000) argues (appropriately, in our view) for after-tax valuation of portfolio assets, pretax valuation is much more common. Pretax valuation also avoids the complexities of Social Security taxation (Thomas, 1999).

In summary, we discount the maximum PIA (adjusted for early retirement) over the timeline discussed. This maximum PIA is constant in real, not nominal, dollars. For married workers, we assume the spouse never worked; the spouse receives benefits based on the worker's income, not his/her own. We add the 50% spousal benefit over the same timeline used for single retirees. Finally, we then replace the worker-plus-spousal 150% with the survivor's [either worker's or widow(er)'s] 100% for the years the joint life expectancy exceeds the single life expectancy.

3.3.3. Discounting the cash flows

We discount the constant real cash flows using a 3.95% real yield to maturity on inflation-indexed treasury securities from June 2000; we do so based on the similarities between TIPS and Social Security that we noted earlier. Our approach is not the first to use real rates to value Social Security benefits. Newmark and Walden (1995) suggest a 1%–3% range is appropriate for most individuals. Steuerle (1996) uses a 2% rate. Neither, however, used market-based real rates. Our market-based rates provide an unbiased valuation. In the remainder of this subsection, we consider alternate discount rate approaches.

The discount rate for valuing Social Security benefits should be based only on expected future cash flows. It should not be a function of imputed returns on past contributions. Many find the imputed returns on Social Security are very low or negative (see Steuerle & Bakija, 1994). Leimer (1995) and Munnell (1998) calculate them to be less than 2%. Further, investment in Social Security is not a choice. If it were, these imputed returns would be more relevant to our valuation and asset mix analysis.

Our approach relies on the market yield-to-maturity curve rather than attempting to develop a theoretical spot rate curve to discount each Social Security payment at an exact rate. Using market yields is not problematic—the TIPS yield curve is very flat, so the inaccuracy is slight.

We do not make risk adjustments to the discount rate; we rely on the risk-free TIPS return. Instead, we incorporate risk *via* the options approach discussed in section 3.4.

3.3.4. Results of discounted cash flow

Table 1 presents our estimates of the net present value of Social Security benefits. It relies on the formula described above and detailed here.

$$Value_{SS} = \frac{1}{\left(1 + \frac{TIPS\ Yield}{12}\right)^{Months\ until\ Retirement}} \times \frac{\left[1 - \left(1 + \frac{TIPS\ Yield}{12}\right)^{-Months\ in\ Retirement}\right]}{\frac{TIPS\ Yield}{12}} \times Benefit \tag{1}$$

It reflects our assumptions about coverage levels, work life, job tenure, age, mortality, discount rates, taxation, salary levels, and inflation. (It does not reflect the risk-adjustment

Table 1
Estimates of high-earner Social Security wealth

Age	Single	Married
25	$ 38,645	$ 65,636
30	$ 47,376	$ 80,096
35	$ 57,889	$ 97,790
40	$ 70,958	$119,330
45	$ 92,146	$154,504
50	$114,898	$191,272
55	$142,046	$234,679
60	$181,883	$298,157
62	$202,731	$330,863
65	$190,006	$318,356
70	$162,964	$275,189
75	$135,538	$234,351
80	$108,821	$192,451
85	$ 82,967	$151,247

Estimated present value of Social Security benefits given assumptions listed below and explained in the text.

Coverage	Maximum PIA ($1,433 in 2000), adjusted for early retirement penalties
Wages	Social security maximum ($76,200 in 2000), adjusted for inflation
Job tenure	From age 21 to 61
Retirement age	62
Mortality	Based on gender-neutral IRS actuarial tables
Discount rate	TIPS yield to maturity (3.95% in June 1999)
Spouse	Non-working, entitled to 50% of worker PIA (as spouse) or 100% of worker PIA (as widow(er))

described in section 3.4 below.) Note that Social Security wealth for couples is about two-thirds greater than for individuals. Roughly three-quarters of the increase is due to the spousal benefit with the remainder coming from the widow(er)'s benefit. For both couples and individuals, Social Security wealth increases until retirement and then declines. This pattern is similar to that expected of a financial portfolio.

Consider a simple example from Table 1—Social Security wealth in 2000 for a single sixty-two-year old. The full retirement age for those born in 1938 is 65 years and 2 months; accordingly, she is retiring 38 months early and are only entitled to a monthly benefit 79.17% of the maximum $1,433 PIA, or $1,134. The 79.17% reflects 5/9ths of 1% reduction for the first 36 months and 5/12ths of 1% reduction for the two extra months. According to the IRS unisex life-expectancy tables this sixty-two-year old can expect to live 22.5 years and will spend 270 months in retirement. Using Eq. (1) and the 3.95% real TIPS yield, the present value of Social Security wealth is $202,731. While monthly benefits will increase in nominal terms from the $1,134, they stay constant in real terms and are correctly valued with the real TIPS yield.

Now add two changes—marriage and valuation before retirement; consider Social Security wealth in 2000 for married fifty-year olds. The full retirement age for those born in 1950 is 66 years; so for a fifty-year-old retiring at 62, they are retiring 48 months early and are only entitled to a monthly benefit 75% of the maximum $1,433 PIA, or $1,075. Note that we use the same $1,433 PIA; while this amount will increase in nominal terms over the next twelve

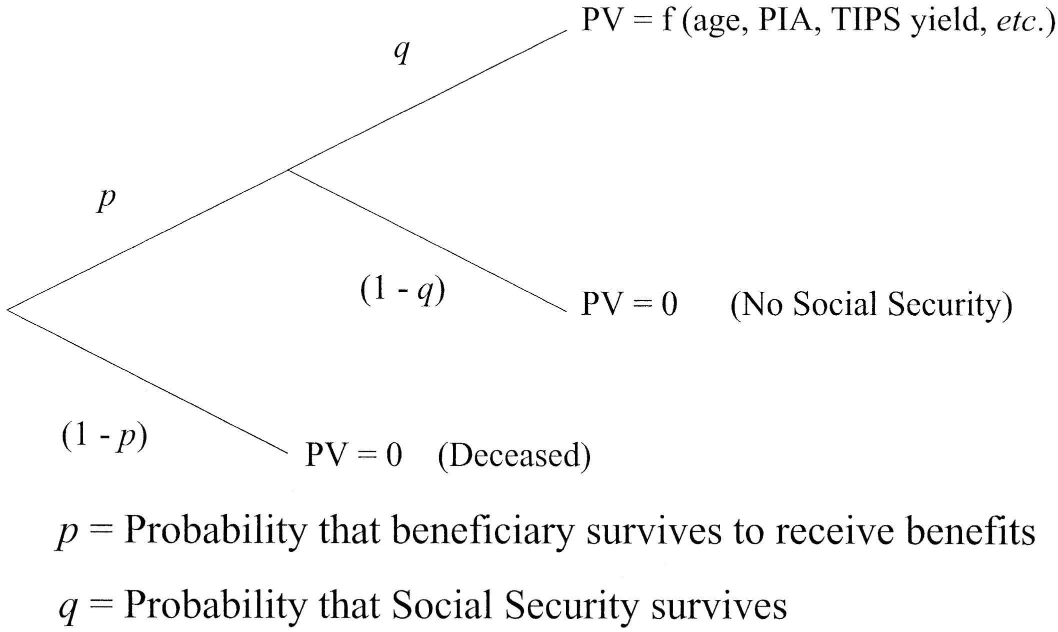


Fig. 1. Binomial options evaluation tree.

years before retirement, it is constant in real terms (and, therefore, appropriately discounted with the TIPS yield). According to the IRS life-expectancy tables, a single fifty-year old life expectancy is 33.1 years and a joint life expectancy is 39.2 years. The couple can expect 21.1 years of 150% retiree-plus-spouse benefits and an additional 6.1 years of 100% retiree or widow(er) benefits. Think of this as equating to two components—a $1,075 benefit starting in 144 months that lasts 326.4 months and an additional $537 benefit starting in 144 months that lasts 253.2 months. Using Eq. (1) and the 3.95% TIPS yield, the present value of the $1,075 benefit is $133,823; the present value of the $537 benefit is $57,449. Together these values are the $191,272 shown in Table 1.

3.4. Risk adjustment: the binomial options overlay

The present values of Social Security benefits are calculated from constant real cash flows (if alive and Social Security operates as planned); they do not specifically include risk adjustments to the discount rate. To incorporate risk, we prefer to overlay a binomial-option valuation approach because it allows cleaner specification of assumptions. For example, rather than estimating a discount rate adjustment for the vagaries of potential benefit changes, we use probabilities to capture the same effect. Our recommended approach includes a probability of living long enough to start benefits at age 62. It also includes a probability of Social Security continuing to exist. Conversely, Social Security not existing is equivalent to a 100% benefit reduction. This simple approach encompasses a range of other possibilities; for example, a 5% probability of zero Social Security benefits is equivalent to a 10% probability of benefits being reduced 50%. Fig. 1 portrays our approach graphically and Eq.

(2) does so mathematically.

$$PV_{risky} = p[qPV_{riskfree} + (1-q)\ PV_{noSS}] + (1-p)\,PV_{dead} = pqPV_{riskfree} \tag{2}$$

where

PV_{risky} = risk-adjusted and survival-adjusted present value,
p = probability of survival to age 62 of the beneficiary (and spouse),
q = probability of survival for the Social Security system,
$PV_{riskfree}$ = net present value computed above using Eq. (1) with the risk-free rate,
PV_{noSS} = the present value without Social Security, and
PV_{dead} = the present value when dead.

Both PV_{noSS} and PV_{dead} are zero. The risk-adjusted present value simplifies to $pqPV_{riskfree}$. For example, if there is a 95% chance of survival of both the beneficiary and the Social Security system, the risk-adjusted present value is 90.25% of the net present value computed in Table 1. In our valuation, we assume—for simplicity—this value is 100% of the unadjusted present value (i.e., $pq = 100\%$). Given the demographic trends influencing Social Security, this assumption is debatable, but quantifying the probability of survival of the Social Security system is beyond the scope of this paper. Those more pessimistic should use a lower percentage when applying this binomial options approach.

The binomial options overlay approach to uncertainty about Social Security's future is a simple and tractable alternative to adjusting the TIPS yield with a risk premium. For example, reconsider the fifty-year-old high-earning couple; under the assumptions used in this paper (and as we demonstrated in section 3.3), their present value of Social Security benefits is $191,272. A 2% risk premium lowers the present value of Social Security benefits by $68,135. This is the same as assuming the probability of Social Security not surviving is 35.6%. Similarly, a 1% risk premium is equivalent to a 20.0% probability of no Social Security. We suspect that most consumers of financial planning advice (and many financial professionals) will find the probability approach in the options overlay more intuitive than the risk premium.

4. Strategic asset allocation implications

Having computed the present value of Social Security benefits, we can investigate the effect of Social Security wealth on the asset mix decision. We apply four asset-mix decision rules—simple fixed mixes, life-cycle rules, consensus expert views and mean-variance optimization. In each case, the impact is dramatic.

Before continuing, we should clarify our terminology. The "financial portfolio" is the classic focus of the investment manager—stocks, bonds, and so forth. The "total portfolio" includes all relevant assets discussed in Scott (1997) and Reichenstein (1998, 2000). Somewhere between these portfolio concepts is an "expanded portfolio" that is the financial portfolio plus Social Security wealth. Our analysis focuses only on the expanded portfolio. While doing so is incomplete from a total portfolio viewpoint, this approach isolates Social Security's impact.

To demonstrate the impact of Social Security wealth on portfolios, we must first quantify the portfolios affected. Note that Social Security wealth is measured in dollars, but asset-mix decision rules are expressed in percentages. To bridge this gap, we compute four realistic, hypothetical portfolios. The first three hypothetical portfolios are based on savings rates of 5, 10 and 15% of income per year over a working lifetime (age 21–61). Ten-percent and fifteen-percent savings rules are common advice (Clements, 1998) and apply to wages earned. Recall that we assumed earnings of $76,200 in 2000, adjusted this amount for inflation, and assumed it is earned in all years before retirement. (This unrealistically assumes maximum earnings at age 21 and proportional lifelong savings. This is both a simplifying and a conservative assumption. High early savings and lifelong savings both increase the financial portfolio, which diminishes the impact of Social Security wealth on the expanded portfolio.) Savings grow at a conservative rate of 6.5%. For retirees, we assume savings stopped at retirement and spending begins based on a rolling 20-year 6.5% annuity; we update the payout each year to include a new 20-year remaining life. This avoids relying on a specific insurer's life annuity payout rate, but our approach's average payout approximates several annuities we did examine. The fourth hypothetical portfolio uses the formula from the *Millionaire Next Door* (MND) bestseller. Stanley and Danko (1996, p. 13) suggest an investor is a "prodigious accumulator of wealth" if the following equation holds:

$$Net\ Worth >= \frac{Age \times Income}{10} \tag{3}$$

We assume our fourth portfolio equal to this value through the beginning of retirement. For example, our fifty-year-old high-earner has a financial portfolio of $381,000 [50 × $76,200 ÷ 10].

4.1. Four asset allocation strategies

The simplest strategic asset allocation that we consider is the classic fixed mix of 60% stocks and 40% bonds (Maginn & Tuttle, 1990). The standard interpretation of this and other asset allocation rules is that they apply to financial portfolios only, not more inclusive portfolios.

The 60/40 fixed mix, while simple, does not recognize life-cycle changes. Wealth, risk aversion and investment horizon all change over a life cycle. In response, Bogle (1994) and others advocate a simple rule of thumb where a portfolio's bond weight (in percentage) should be the investor's age. A 40 year old should be 60% in stock, and a 60 year old should be 40% in stock.

A consensus of many investment experts offers potential enhancements to both the classic 60/40 mix and the simple life-cycle mix. Malkiel (1996) offers "life-cycle. . .savings allocations" which vary with an investor's age and correspond with an investor's tolerance for risk. His guide provides four sample portfolios ranging from a 70/30 split for the Mid-Twenties age group to a 30/70 mix for those in the Late-Sixties-and-beyond group. Malkiel's portfolios are reasonable guides to this class of asset-mix decision rules. Reichenstein (1996)

Table 2
Summary of the four asset allocation strategies

Asset-mix decision rule	Description	Citation
Fixed Mix	Hold 60% stocks and 40% bonds.	Maginn and Tuttle (1990)
Life Cycle Mix	Hold (1-*age*)% in stocks and (*age*)% in bonds.	Bogle (1994)
Consensus Expert Mix	Hold stocks and bonds in accordance with Malkiel's "life-cycle savings allocations."	Malkiel (1996)
Mean-Variance Optimization	Hold stocks and bonds in proportions found on the mean-variance efficient frontier.	Markowitz (1959)

shows consensus among asset allocation strategies from several sources including Malkiel; Fisher and Statman (1997) also illustrate commonalities across expert asset allocations.

The fourth strategic asset allocation approach we consider is mean-variance optimization. Under mean-variance optimization, we examine portfolio implications for a range of risk aversion levels. The four asset allocation strategies are summarized in Table 2.

4.2. Implications for the classic 60/40 mix

Table 3 treats Social Security wealth as a bond and shows expanded portfolio asset mixes when the financial portfolio is a 60/40 fixed mix. A fifty-year-old 5% saver who thinks he owns more stocks than bonds (the 60/40 mix) actually only owns half as much stocks as bonds in his expanded portfolio (35% stocks/65% bonds) when Social Security wealth is included. That is, holding 60% stocks and 40% bonds in the financial portfolio really equates to holding 35% stocks and 65% bonds (actual bonds plus Social Security wealth) in the expanded portfolio. We rely on the following formula:

$$\%Stocks_{expanded\ portfolio} = \frac{\%Stocks_{financial\ portfolio} \times Wealth_{financial\ portfolio}}{Wealth_{financial\ portfolio} + Wealth_{social\ security}} \quad (4)$$

Fifty-year-old couples, with more Social Security wealth, are even more underweighted in stocks. Better savers, with larger financial portfolios, obviously have a larger stock allocation in their expanded portfolio, but none of the four types of savers has even a 50% stock allocation. In no case are seemingly equity-heavy portfolios even majority-equity portfolios. Because Social Security wealth grows at the same time as the financial portfolio grows, these patterns are relatively consistent over a lifetime. Fig. 2 shows the resultant expanded portfolio asset mix for a fifty-year-old 10%-saver couple when the financial portfolio is a 60/40 fixed mix.

The discussion above is descriptive—it describes the real consequences of applying the fixed mix to a financial portfolio. What follows is prescriptive—it describes how to implement a financial portfolio in order to achieve a desired expanded portfolio. Table 4 shows the required asset mixes in the financial portfolio to obtain a 60/40 fixed mix in the expanded portfolio; that is, Table 4 shows how to implement a 60/40 fixed mix in the expanded portfolio by adjusting the financial portfolio. We use the following formula:

Table 3
Implications of a 60/40 mix in the financial portfolio for the expanded portfolio

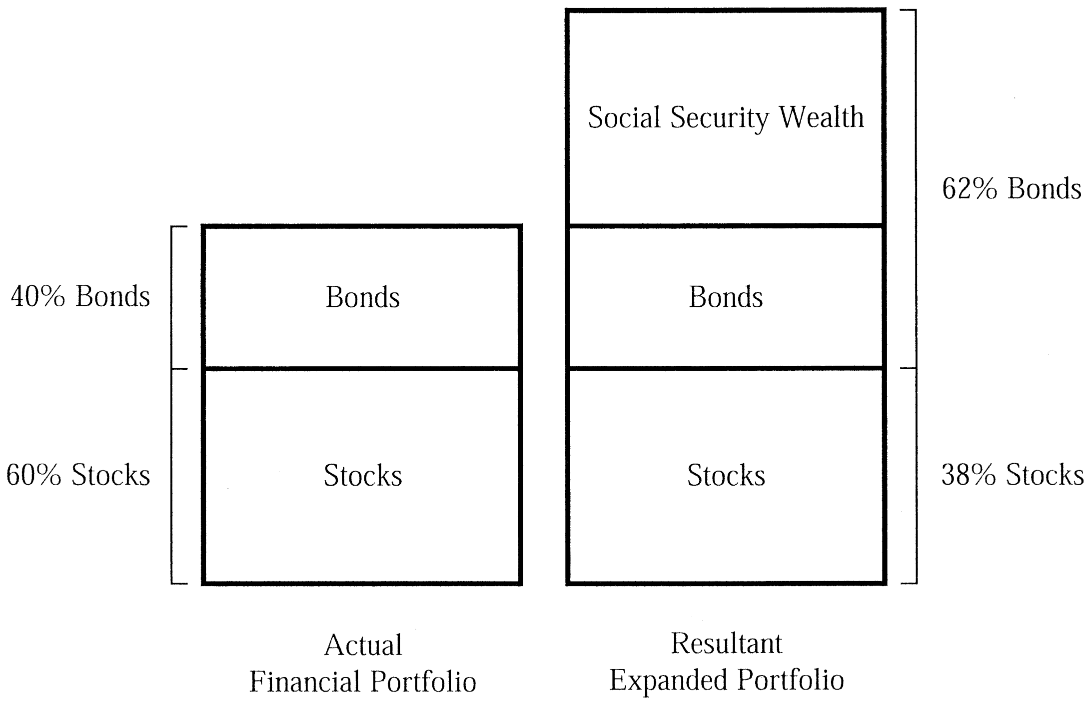
Demography		Perceived financial portfolio		Resultant expanded portfolio including Social Security wealth							
				5% Saver		10% Saver		15% Saver		MND Saver	
Age	Status	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds
30	Single	60%	40%	29%	71%	40%	60%	45%	55%	50%	50%
	Married	60%	40%	22%	78%	32%	68%	38%	62%	44%	56%
40	Single	60%	40%	36%	64%	45%	55%	49%	51%	49%	51%
	Married	60%	40%	28%	72%	38%	62%	44%	56%	43%	57%
50	Single	60%	40%	35%	65%	44%	56%	49%	51%	46%	54%
	Married	60%	40%	28%	72%	38%	62%	43%	57%	40%	60%
60	Single	60%	40%	33%	67%	43%	57%	47%	53%	43%	57%
	Married	60%	40%	26%	74%	36%	64%	42%	58%	36%	64%
62	Single	60%	40%	31%	69%	41%	59%	46%	54%	42%	58%
	Married	60%	40%	24%	76%	34%	66%	40%	60%	35%	65%
65	Single	60%	40%	29%	71%	40%	60%	45%	55%	41%	59%
	Married	60%	40%	22%	78%	32%	68%	38%	62%	34%	66%
70	Single	60%	40%	27%	73%	38%	62%	43%	57%	40%	60%
	Married	60%	40%	20%	80%	30%	70%	36%	64%	33%	67%
80	Single	60%	40%	24%	76%	35%	65%	40%	60%	38%	62%
	Married	60%	40%	17%	83%	26%	74%	32%	68%	29%	71%

Expanded portfolio stock/bond mix resulting from adding Social Security wealth to a financial portfolio with a 60/40 fixed mix. Social security wealth is treated as a bond and uses values from Table 1 computed using real TIPS yields for a high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996).

$$\%Stocks_{financial\ portfolio} = \frac{\%Stocks_{expanded\ portfolio} \times (Wealth_{financial\ portfolio} + Wealth_{social\ security})}{Wealth_{financial\ portfolio}} \quad (5)$$

Again, consider a single fifty-year-old 5% saver; he or she should be very slightly leveraged in her financial portfolio. This slight leverage (103% equities) is equivalent to margin borrowing. The fifty-year-old couple should be somewhat more heavily leveraged (131% in equity). Margin borrowing is only required for the worst savers among our four types of fifty year olds; a fifty-year-old 10% saver should have 81% stock in her financial portfolio if single or 95% if married. Fig. 3 shows the required financial portfolio asset mix for a fifty-year-old 10%-saver couple when the desired expanded portfolio is a 60/40 fixed mix. As one can see in Table 4, Social Security wealth has most significant impact for those just beginning to save (youngest), those no longer saving (oldest), and those that save the least.

All of the leveraged asset mixes described in this paper are feasible. Purchasing \$100 of stock on margin with \$50 equity is equivalent to a portfolio with 200% stock/-100% bonds if one classifies the margin debt, a fixed obligation, as a (short) bond. Any asset allocation with the bond weighting greater than or equal to −100% is possible with ordinary margin accounts. Stock index futures offer even greater leverage potential. We considered margined



Fifty-year-old high-earner 10%-saver couple

Fig. 2. Implications of Social Security wealth on asset allocation.

positions rather than constrained allocations in order to highlight the dramatic impact of incorporating Social Security wealth in portfolios.

To demonstrate the calculations behind Tables 3 and 4, consider a hypothetical investor with a $200,000 financial portfolio invested in a 60/40 mix. That is, $120,000 is in stocks and $80,000 is in bonds. Assume Social Security wealth is valued at $100,000. The $120,000 in stocks is 40% of the $300,000 expanded portfolio. To achieve a 60/40 mix in the expanded portfolio, 60% of $300,000, or $180,000, must be invested in stocks. This value would represent 90% of the $200,000 financial portfolio. The values in this example also work with Eqs. (4) and (5).

4.3. Implications for the simple life-cycle mix

If our fifty-year-old investor follows our second asset allocation strategy, the simple life-cycle mix, it indicates a 50% position in bonds. For the 5% saver, the target 50/50 (stock/bond) mix in the financial portfolio results in an expanded portfolio mix of 29/71 if single and 23/77 if married. See Table 5. Even though the life-cycle mix dictates a majority-equity position for those younger than fifty years old (because the bond weight

Table 4
Implications of a 60/40 mix in the expanded portfolio for the financial portfolio

Demography		Desired expanded portfolio		Resultant financial portfolio							
				5% Saver		10% Saver		15% Saver		MND Saver	
Age	Status	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds
30	Single	60%	40%	122%	−22%	91%	9%	81%	19%	72%	28%
	Married	60%	40%	165%	−65%	112%	−12%	95%	5%	81%	19%
40	Single	60%	40%	100%	0%	80%	20%	73%	27%	74%	26%
	Married	60%	40%	128%	−28%	94%	6%	83%	17%	83%	17%
50	Single	60%	40%	103%	−3%	81%	19%	74%	26%	78%	22%
	Married	60%	40%	131%	−31%	95%	5%	84%	16%	90%	10%
60	Single	60%	40%	108%	−8%	84%	16%	76%	24%	84%	16%
	Married	60%	40%	139%	−39%	99%	1%	86%	14%	99%	1%
62	Single	60%	40%	115%	−15%	88%	12%	78%	22%	86%	14%
	Married	60%	40%	150%	−50%	105%	−5%	90%	10%	102%	−2%
65	Single	60%	40%	122%	−22%	91%	9%	81%	19%	87%	13%
	Married	60%	40%	164%	−64%	112%	−12%	95%	5%	105%	−5%
70	Single	60%	40%	131%	−31%	96%	4%	84%	16%	90%	10%
	Married	60%	40%	181%	−81%	120%	−20%	100%	0%	110%	−10%
80	Single	60%	40%	148%	−48%	104%	−4%	89%	11%	96%	4%
	Married	60%	40%	215%	−115%	137%	−37%	112%	−12%	123%	−23%

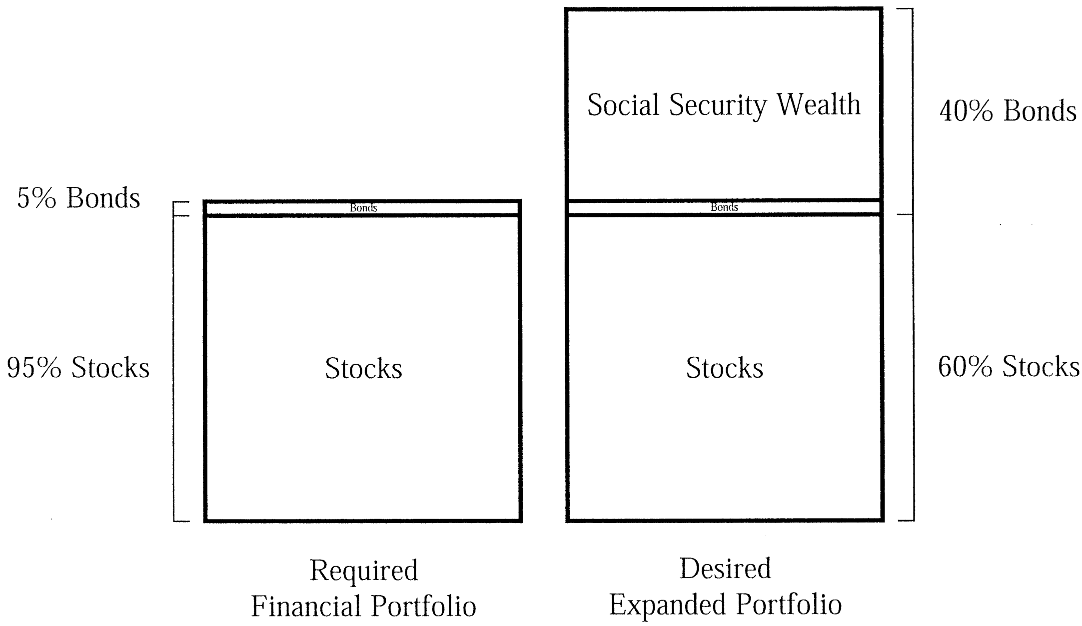
Required financial portfolio asset allocation necessary to achieve a 60/40 fixed mix in the expanded portfolio, which includes Social Security wealth. Social security wealth is treated as a bond and uses values from Table 1 computed using real TIPS yields for a high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996). Stock positions greater than 100% are purchased on margin; those greater than 200% require stock futures to implement. Negative bond positions represent margin borrowing.

equals the investor's age), only the youngest, best savers have such a majority-equity position in their expanded portfolios.

Table 6 shows how to implement a life-cycle mix in the expanded portfolio by adjusting the financial portfolio. If she really desired a 50/50 mix in her expanded portfolio, the required mix in the fifty-year-old investor's financial portfolio is 85/15 if single or a margined 109/-9 if married. To offset the bond-like value of Social Security benefits, all investors, except the oldest, need at least a majority-equity position in their financial portfolio.

4.4. Implications for the consensus expert mix

Table 7 consolidates the expert's views and describes the impact of Social Security wealth on the expanded portfolio asset mix. We make two simplifications—we combine cash with bonds and we ignore the within-class allocations. For our same fifty-year-old 5% saver, the consensus expert target of 53/47 (interpolated from Malkiel, 1996) yields an actual expanded portfolio asset mix of 31/69. Again, only the youngest and best savers following the asset-mix decision rule have more than a majority-equity position. Table 8 shows how to implement the consensus expert mix in the expanded portfolio by adjusting the financial portfolio. To achieve the desired 53/47 split in the expanded portfolio would require a 91/9



Fifty-year-old high-earner 10%-saver couple

Fig. 3. Adjusting the financial portfolio to reflect Social Security wealth.

mix in the financial portfolio. Again, to offset Social Security's impact on the financial portfolio, most investors need more than 50% stock in their financial portfolio. While these results are similar to the life-cycle approach, we include them to demonstrate the veracity of our result that including Social Security wealth has a profound impact on strategic asset allocation—whatever the asset-mix decision rule.

4.5. Implications for optimization

We have shown Social Security wealth has a clear impact on the portfolio asset mix under three common decision rules. Here we discuss its impact under the more sophisticated Markowitz (1959) approach that calculates the efficient frontier of minimum risk portfolios for a given return level—mean-variance optimization (MVO). As before, we can state that excluding Social Security wealth will greatly affect an individual's optimal portfolio.

Many researchers (Siegel, 1998; Bodie, 1990; Brynjolfsson & Fabozzi, 1999; Chen & Terrien, 1999; Dalio & Bernstein, 1999; Lamm, 1998; Phoa, 1999; Rudolph-Shabinsky, 2000) find that adding TIPS to stock/bond portfolios enhances portfolio efficiency and that TIPS displace ordinary bonds along much of the efficient frontier. TIPS shift the mean-variance efficient frontier because of their impact on the optimization inputs—expected means, variance and correlations. We consider these in turn. First, the expected return on TIPS is low when compared to stocks and bonds in nominal terms, but they compare favorably in real terms. Second, the variance of TIPS is lower than other asset classes. While

Table 5
Implications of a life-cycle mix in the financial portfolio for the expanded portfolio

Demography		Perceived financial portfolio		Resultant expanded portfolio including Social Security wealth							
				5% Saver		10% Saver		15% Saver		MND Saver	
Age	Status	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds
30	Single	70%	30%	34%	66%	46%	54%	52%	48%	58%	42%
	Married	70%	30%	25%	75%	37%	63%	44%	56%	52%	48%
40	Single	60%	40%	36%	64%	45%	55%	49%	51%	49%	51%
	Married	60%	40%	28%	72%	38%	62%	44%	56%	43%	57%
50	Single	50%	50%	29%	71%	37%	63%	40%	60%	38%	62%
	Married	50%	50%	23%	77%	31%	69%	36%	64%	33%	67%
60	Single	40%	60%	22%	78%	29%	71%	32%	68%	29%	71%
	Married	40%	60%	17%	83%	24%	76%	28%	72%	24%	76%
62	Single	38%	62%	20%	80%	26%	74%	29%	71%	27%	73%
	Married	38%	62%	15%	85%	22%	78%	25%	75%	22%	78%
65	Single	35%	65%	17%	83%	23%	77%	26%	74%	24%	76%
	Married	35%	65%	13%	87%	19%	81%	22%	78%	20%	80%
70	Single	30%	70%	14%	86%	19%	81%	21%	79%	20%	80%
	Married	30%	70%	10%	90%	15%	85%	18%	82%	16%	84%
80	Single	20%	80%	8%	92%	12%	88%	13%	87%	13%	87%
	Married	20%	80%	6%	94%	9%	91%	11%	89%	10%	90%

Expanded portfolio stock/bond mix resulting from adding Social Security wealth to a financial portfolio with a life-cycle asset allocation. The life-cycle mix invests a percentage of the portfolio in bonds equal to the investor's age. Social security wealth is treated as a bond and uses values from Table 1 computed using real TIPS yields for a high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996).

ordinary bonds' variance reflects changes in both real yields and inflation expectations, TIPS's variance only reflects changes in real yields. Dalio and Bernstein (1999) estimate this is responsible for only 30% of bonds' overall variance. Third, TIPS have an unusually low correlation with other asset classes. TIPS have low correlation with nominal bonds because of their opposite reaction to inflation. TIPS have low correlation with stocks because stocks are empirically poor inflation hedges. For long horizons, Dalio and Bernstein (1999) estimate TIPS-nominal bond correlation at -0.01 and TIPS-stock correlation at -0.24. Brynjolfsson and Rennie (1999), Chen and Terrien (1999) and Phoa (1999) also estimate negative or very low correlations.

Social Security, like TIPS, affects the optimal portfolio through MVO inputs—expected means, variance and correlations. In section 3.3, we related Social Security returns to TIPS returns. Variance on Social Security wealth, like TIPS, is low and reflects only changes in real yields (but Social Security variance could be even lower since it excludes trading-induced noise). Likewise, TIPS correlation is a reasonable guide to Social Security correlation. Social security has low correlation with bonds because of its opposite relation to inflation. For most workers, Social Security wealth is essentially unrelated to stock returns; low or negative correlations for Social Security wealth are appropriate. Since Social Security behaves much like TIPS with respect to optimization inputs, Social Security wealth will also

Table 6
Implications of a life-cycle mix in the expanded portfolio for the financial portfolio

Demography		Desired expanded portfolio		Required financial portfolio							
				5% Saver		10% Saver		15% Saver		MND Saver	
Age	Status	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds
30	Single	70%	30%	142%	−42%	106%	−6%	94%	6%	85%	15%
	Married	70%	30%	192%	−92%	131%	−31%	111%	−11%	95%	5%
40	Single	60%	40%	100%	0%	80%	20%	73%	27%	74%	26%
	Married	60%	40%	128%	−28%	94%	6%	83%	17%	83%	17%
50	Single	50%	50%	85%	15%	68%	32%	62%	38%	65%	35%
	Married	50%	50%	109%	−9%	79%	21%	70%	30%	75%	25%
60	Single	40%	60%	72%	28%	56%	44%	51%	49%	56%	44%
	Married	40%	60%	93%	7%	66%	34%	58%	42%	66%	34%
62	Single	38%	62%	73%	27%	55%	45%	50%	50%	54%	46%
	Married	38%	62%	95%	5%	66%	34%	57%	43%	65%	35%
65	Single	35%	65%	71%	29%	53%	47%	47%	53%	51%	49%
	Married	35%	65%	96%	4%	65%	35%	55%	45%	62%	38%
70	Single	30%	70%	66%	34%	48%	52%	42%	58%	45%	55%
	Married	30%	70%	90%	10%	60%	40%	50%	50%	55%	45%
80	Single	20%	80%	49%	51%	35%	65%	30%	70%	32%	68%
	Married	20%	80%	72%	28%	46%	54%	37%	63%	41%	59%

Required financial portfolio asset allocation necessary to achieve a life-cycle asset allocation in the expanded portfolio, which includes Social Security wealth. The life-cycle mix invests a percentage of the portfolio in bonds equal to the investor's age. Social security wealth is treated as a bond and uses values from Table 1 computed using real TIPS yields for a high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996). Stock positions greater than 100% are purchased on margin; negative bond positions represent margin borrowing.

enhance portfolio efficiency and be part of optimal portfolios. See Bajtelsmit and Turner (1998).

In Tables 9 and 10, we demonstrate a particular implementation of mean-variance optimization (MVO) with Social Security. Tables 3 through 8 (which relate to the other three asset-mix decision rules) vary in three dimensions—age, savings rates and marital status. MVO adds many more dimensions of variability including risk aversion, means, variances and correlations. Even a small-scale optimization with three assets (bonds, stocks and Social Security wealth) adds 10 degrees of freedom (3 expected returns, 3 standard deviations, 3 correlations and risk aversion). Rather than attempt to build tables comparable to Tables 3 through 8 across 13 dimensions, we illustrate how Social Security wealth affects optimal strategic asset allocation in a scenario and leave it to the reader to conduct MVO with inputs aligned with their beliefs.

We first compute the MVO frontier with two assets—stocks and bonds. We use expected returns of 10.5% and 6.5%, respectively. The less-than-historical equity risk premium is conservative (Cornell, 1999). We use a 0.6 correlation between stocks and bonds and standard deviations of 20% and 9%, respectively. From this two-asset frontier, we impute

Table 7
Implications of Malkiel mix in the financial portfolio for the expanded portfolio

Demography		Perceived financial portfolio		Resultant expanded portfolio including Social Security wealth							
				5% Saver		10% Saver		15% Saver		MND Saver	
Age	Status	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds
30	Single	65%	35%	32%	68%	43%	57%	48%	52%	54%	46%
	Married	65%	35%	24%	76%	35%	65%	41%	59%	48%	52%
40	Single	60%	40%	36%	64%	45%	55%	49%	51%	49%	51%
	Married	60%	40%	28%	72%	38%	62%	44%	56%	43%	57%
50	Single	53%	47%	31%	69%	39%	61%	43%	57%	41%	59%
	Married	53%	47%	24%	76%	33%	67%	38%	62%	35%	65%
60	Single	43%	57%	24%	76%	31%	69%	34%	66%	31%	69%
	Married	43%	57%	19%	81%	26%	74%	30%	70%	26%	74%
62	Single	39%	61%	20%	80%	27%	73%	30%	70%	27%	73%
	Married	39%	61%	16%	84%	22%	78%	26%	74%	23%	77%
65	Single	37%	63%	18%	82%	24%	76%	28%	72%	25%	75%
	Married	37%	63%	14%	86%	20%	80%	23%	77%	21%	79%
70	Single	30%	70%	14%	86%	19%	81%	21%	79%	20%	80%
	Married	30%	70%	10%	90%	15%	85%	18%	82%	16%	84%
80	Single	30%	70%	12%	88%	17%	83%	20%	80%	19%	81%
	Married	30%	70%	8%	92%	13%	87%	16%	84%	15%	85%

Expanded portfolio stock/bond mix resulting from adding Social Security wealth to a financial portfolio with a consensus-expert asset allocation. The consensus-expert mix is per Malkiel (1996). Social security wealth is treated as a bond and uses values from Table 1 computed using real TIPS yields for a high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996).

risk-aversion coefficients, θ, for 100/0, 90/10, 80/20, and so forth, portfolios. These risk-aversion coefficients maximize utility under the standard framework:

$$\max U_p = \mathrm{E}(r_p) - \theta \mathrm{E}(\sigma_p) \tag{6}$$

Higher θ implies higher risk aversion. While the levels of the risk-aversion coefficients in Tables 9 and 10 appear arbitrary, they are designed to map to "round number" asset mixes in the financial portfolio.

We then apply these risk-aversion coefficients to MVO in expanded portfolios that include Social Security wealth. We consider single and married fifty-year-olds with different savings. We use the Table 1 present value of Social Security benefits and the hypothetical financial portfolios for 5%, 10%, 15% and MND savers to calculate the percentage of the expanded portfolio that Social Security wealth represents. We constrain the MVO to hold Social Security wealth in this constant proportion.

Unlike the other three asset-mix decision rules, we treat Social Security wealth as a distinct asset class—not an ordinary bond. We use a 6.45% expected return on Social Security that reflects 2.5% inflation and the 3.95% real TIPS yield used throughout this paper. We use a 3% standard deviation, −0.2 correlation with stocks and 0.0 correlation with nominal bonds. The optimization inputs are illustrative, not authoritative, but represent a harmonization of many sources (Bodie, 1990; Brynjolfsson & Fabozzi, 1999; Chen &

Table 8
Implications of Malkiel mix in the expanded portfolio for the financial portfolio

Demography		Desired expanded portfolio		Required financial portfolio							
				5% Saver		10% Saver		15% Saver		MND Saver	
Age	Status	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds
30	Single	65%	35%	132%	−32%	99%	1%	87%	13%	78%	22%
	Married	65%	35%	179%	−79%	122%	−22%	103%	−3%	88%	12%
40	Single	60%	40%	100%	0%	80%	20%	73%	27%	74%	26%
	Married	60%	40%	128%	−28%	94%	6%	83%	17%	83%	17%
50	Single	53%	47%	91%	9%	72%	28%	66%	34%	69%	31%
	Married	53%	47%	115%	−15%	84%	16%	74%	26%	80%	20%
60	Single	43%	57%	77%	23%	60%	40%	54%	46%	60%	40%
	Married	43%	57%	99%	1%	71%	29%	62%	38%	71%	29%
62	Single	39%	61%	75%	25%	57%	43%	51%	49%	56%	44%
	Married	39%	61%	97%	3%	68%	32%	58%	42%	66%	34%
65	Single	37%	63%	75%	25%	56%	44%	50%	50%	54%	46%
	Married	37%	63%	101%	−1%	69%	31%	58%	42%	65%	35%
70	Single	30%	70%	66%	34%	48%	52%	42%	58%	45%	55%
	Married	30%	70%	90%	10%	60%	40%	50%	50%	55%	45%
80	Single	30%	70%	74%	26%	52%	48%	45%	55%	48%	52%
	Married	30%	70%	107%	−7%	69%	31%	56%	44%	62%	38%

Required financial portfolio asset allocation necessary to achieve a consensus-expert asset allocation in the expanded portfolio, which includes social security wealth. The consensus-expert mix is per Malkiel (1996). Social security wealth is treated as a bond and uses values from Table 1 computed using real TIPS yields for a high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996). Stock positions greater than 100% are purchased on margin; negative bond positions represent margin borrowing.

Terrien, 1999; Dalio & Bernstein, 1999; Ibbotson Associates, 1999; Lamm, 1998; Phoa, 1999; Rudolph-Shabinsky, 2000). For simplicity, we require asset holdings to be in whole percents and constrain stock positions in the expanded portfolio to 0% to 100%.

Table 9 shows the MVO efficient portfolios for the different imputed risk aversion levels. For example, a single 10%-saver 50-year-old whose risk aversion recommends a 90%/10% stock/bond mix if optimizing only her financial portfolio (i.e., $\theta = 0.279$) would choose to hold a 69%/5%/26% stock/bond/Social Security mix in her expanded portfolio. Table 10 shows this is requires a 93%/7% stock/bond mix in the financial portfolio to implement. As before, integrating Social Security wealth under this asset-mix decision rule requires more stockholdings; however, note that the required financial portfolios in Table 10 require only slight adjustments (1–17% shifts) from the a priori financial portfolios with the same risk aversion. These small shifts are for constant risk aversions θ (typically diagonal moves in risk-return space); integrating Social Security into the asset mix decision also allows i) risk reductions for constant expected returns (horizontal moves) or ii) return enhancements for constant risk levels (vertical moves). These horizontal and vertical moves in risk-return space require larger reallocations—akin to those under the first three asset-mix decision rules. Fig.

Table 9. Implications of MVO for the expanded portfolio including social security

Risk aversion	Actual financial portfolio		Resultant expanded portfolio including social security wealth											
			5% Saver			10% Saver			15% Saver			MND Saver		
Status θ	Stocks	Bonds	Stocks	Bonds	Soc Sec	Stocks	Bonds	Soc Sec	Stocks	Bonds	Soc Sec	Stocks	Bonds	Soc Sec
Single fifty-year-old														
0.274	100%	0%	63%	−4%	41%	76%	−2%	26%	82%	−1%	19%	78%	−1%	23%
0.279	90%	10%	57%	2%	41%	69%	5%	26%	75%	6%	19%	71%	6%	23%
0.286	80%	20%	51%	8%	41%	62%	12%	26%	67%	14%	19%	64%	13%	23%
0.296	70%	30%	45%	14%	41%	54%	20%	26%	58%	23%	19%	56%	21%	23%
0.310	60%	40%	39%	20%	41%	47%	27%	26%	50%	31%	19%	48%	29%	23%
0.330	50%	50%	33%	26%	41%	39%	35%	26%	42%	39%	19%	40%	37%	23%
0.360	40%	60%	27%	32%	41%	32%	42%	26%	34%	47%	19%	33%	44%	23%
0.410	30%	70%	21%	38%	41%	24%	50%	26%	26%	55%	19%	25%	52%	23%
0.500	20%	80%	15%	44%	41%	17%	57%	26%	18%	63%	19%	17%	60%	23%
0.691	10%	90%	8%	51%	41%	9%	65%	26%	9%	72%	19%	9%	68%	23%
1.273	0%	100%	2%	57%	41%	2%	72%	26%	1%	80%	19%	2%	75%	23%
	Actual financial		5% Saver			10% Saver			15% Saver			MND Saver		
	Stocks	Bonds	Stocks	Bonds	Soc Sec	Stocks	Bonds	Soc Sec	Stocks	Bonds	Soc Sec	Stocks	Bonds	Soc Sec
Married fifty-year-old														
0.274	100%	0%	53%	−7%	54%	66%	−3%	37%	74%	−2%	28%	70%	−3%	33%
0.279	90%	10%	48%	−2%	54%	60%	3%	37%	67%	5%	28%	64%	3%	33%
0.286	80%	20%	43%	3%	54%	54%	9%	37%	60%	12%	28%	57%	10%	33%
0.296	70%	30%	38%	8%	54%	47%	16%	37%	53%	19%	28%	50%	17%	33%
0.310	60%	40%	33%	13%	54%	41%	22%	37%	46%	26%	28%	43%	24%	33%
0.330	50%	50%	28%	18%	54%	35%	28%	37%	38%	34%	28%	36%	31%	33%
0.360	40%	60%	23%	23%	54%	28%	35%	37%	31%	41%	28%	29%	38%	33%
0.410	30%	70%	18%	28%	54%	22%	41%	37%	24%	48%	28%	22%	45%	33%
0.500	20%	80%	13%	33%	54%	15%	48%	37%	16%	56%	28%	16%	51%	33%
0.691	10%	90%	8%	38%	54%	9%	54%	37%	9%	63%	28%	9%	58%	33%
1.273	0%	100%	3%	43%	54%	2%	61%	37%	2%	70%	28%	2%	65%	33%

Expanded portfolio stock/bond/social security wealth mix resulting from adding social security wealth to a financial portfolio with a mean-variance optimal asset allocation for a given risk aversion level θ. θ is the risk aversion from the utility maximization problem $E(r) - \theta E(\sigma)$. Social security wealth is treated as TIPS and uses values from Table 1 computed using real TIPS yields for a fifty-year-old high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996).

Table 10
Implications of MVO in the expanded portfolio for the financial portfolio

Risk aversion	Required financial portfolio							
	5% Saver		10% Saver		15% Saver		MND Saver	
Status θ	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds
Single fifty-year-old								
0.274	107%	−7%	103%	−3%	101%	−1%	101%	−1%
0.279	97%	3%	93%	7%	93%	7%	92%	8%
0.286	86%	14%	84%	16%	83%	17%	83%	17%
0.296	76%	24%	73%	27%	72%	28%	73%	27%
0.310	66%	34%	64%	36%	62%	38%	62%	38%
0.330	56%	44%	53%	47%	52%	48%	52%	48%
0.360	46%	54%	43%	57%	42%	58%	43%	57%
0.410	36%	64%	32%	68%	32%	68%	32%	68%
0.500	25%	75%	23%	77%	22%	78%	22%	78%
0.691	14%	86%	12%	88%	11%	89%	12%	88%
1.273	3%	97%	3%	97%	1%	99%	3%	97%
Married fifty-year-old								
0.274	115%	−15%	105%	−5%	103%	−3%	104%	−4%
0.279	104%	−4%	95%	5%	93%	7%	96%	4%
0.286	93%	7%	86%	14%	83%	17%	85%	15%
0.296	83%	17%	75%	25%	74%	26%	75%	25%
0.310	72%	28%	65%	35%	64%	36%	64%	36%
0.330	61%	39%	56%	44%	53%	47%	54%	46%
0.360	50%	50%	44%	56%	43%	57%	43%	57%
0.410	39%	61%	35%	65%	33%	67%	33%	67%
0.500	28%	72%	24%	76%	22%	78%	24%	76%
0.691	17%	83%	14%	86%	12%	88%	13%	87%
1.273	7%	93%	3%	97%	3%	97%	3%	97%

Required financial portfolio asset allocation necessary to achieve a mean-variance optimal asset allocation in the expanded portfolio, which includes Social Security wealth. Risk aversion levels θ are from the utility maximization problem $E(r) - \theta E(\sigma)$; specific values of θ displayed in this table relate to asset allocations in Table 9. Expanded portfolio weights are computed from rounded values in Table 9. Social security wealth is treated as TIPS and uses values from Table 1 computed using real TIPS yields for a high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996). Stock positions greater than 100% are purchased on margin; negative bond positions represent margin borrowing.

4, which shows the efficient frontiers with and without Social Security for single fifty-year-olds, illustrates these horizontal- and vertical-shift possibilities.

Fig. 4 shows that for all four savings levels, Social Security wealth shifts the efficient frontier. This is consistent with the research showing TIPS increasing efficiency. The efficient frontiers for expanded portfolios are shorter because required holdings in Social Security wealth are displacing high-risk/high-return stock (which we limited to 100% of the expanded portfolio); the 5% saver's efficient frontier is shortest because Social Security wealth is most significant in her expanded portfolio. Leverage could extend the expanded portfolio frontiers.

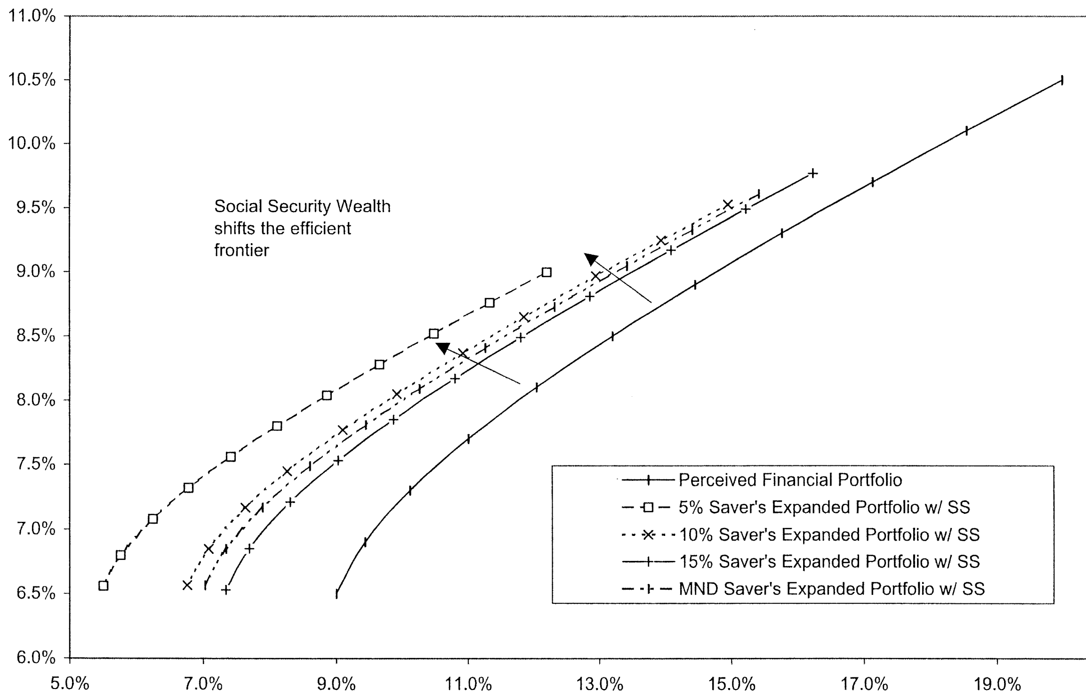


Fig. 4. Efficient frontiers with and without Social Security wealth for a single 50-year-old.

In short, integrating the present value of Social Security benefits shifts the mean-variance efficient frontier and offers substantial risk-reducing or return-enhancing opportunities. Since Social Security wealth has risk-return-correlation characteristics much like an inflation-indexed treasury bond, considering it in the total portfolio has a striking impact on the optimized financial portfolio.

5. Conclusion

5.1. Summary

The typical income-adequacy retirement planning approach, which deducts Social Security benefits from required retirement cash flows, ignores asset mix implications of Social Security wealth. We assert that including Social Security cash flows but ignoring asset mix implications is inconsistent. This paper addresses three questions related to this inconsistency (should we include Social Security? what is its value? and what is its impact?). We first consider the qualitative and quantitative arguments that this is an inconsistency and that Social Security should be included in asset mix decisions. Next, we highlight commonalities in the payment stream from Social Security benefits and TIPS and use those commonalities to value Social Security wealth. Third, we show that under any of the asset-mix decision rules considered, Social Security wealth clearly affects strategic asset allocation.

Common interpretation of the four asset-mix decision rules we consider is that they apply to asset mixes in financial portfolios rather than expanded portfolios that incorporate Social Security wealth. We show that adding Social Security wealth to the financial portfolio results in a dramatically different asset mix in the expanded portfolio. For many, Social Security wealth inverts a seemingly stock-heavy portfolio into a bond-heavy one. Conversely, we show that achieving a desired expanded portfolio mix requires significantly more stock holdings in the financial portfolio. For some, margined stock positions are required to offset the bond-like present value of Social Security benefits.

While we consider a range of circumstances—age, marital status, savings-level and (in the Appendix) gender, income-level and retirement age, we encourage applying our approach to individual circumstances. How, then, should an individual value their Social Security benefits for inclusion in a portfolio? First, we advise completing the Form SSA-7004-SM, Request for Earnings and Benefit Estimate Statement, which is available on www.ssa.gov. In completing the form, pay careful attention to the instructions about average future annual earnings—exclude any cost-of-living increases. (Alternatively, www.ssa.gov/planners/calculators.htm offers three benefit calculators.) Second, find the *Wall Street Journal* yield quote for inflation-indexed treasury securities whose maturity approximates your years to retirement. Third, estimate your life expectancy. IRS Publication 939 has actuarial tables, but you may want to deviate from its median values. Use the yield and life expectancy to discount the estimated benefit. Remember this is a two-stage process—compute the value of the expected benefit annuity as of your expected retirement date and then discount the value of that future lump sum to obtain today's value. See Eq. (1).

5.2. Implications and extensions

The key practical impact of this paper is to demonstrate that the present value of Social Security benefits is properly considered part of investors total portfolio and that excluding Social Security has a striking impact on their finances and investment decisions. A key contribution of this paper is providing a well-reasoned means of quantifying Social Security wealth. Once a dollar value is assigned to Social Security, it can be properly integrated into a portfolio.

Rarely do asset-mix prescriptions incorporate marital status; none that we consider does so. Some suggest that single investors can accept more risk (e.g., Gutner, 2000). The present value of a couple's Social Security annuity is more valuable than a single person's annuity. If asset-mix decision rules apply to financial portfolios, couples are inherently implementing a less risky expanded portfolio; conversely, singles already have a more risky expanded portfolio—without adjusting the financial portfolio. If, instead, the asset-mix decision rules apply to expanded portfolios, couples require riskier, stock-heavy financial portfolios to offset their greater Social Security wealth.

Another implication of this paper is that question about the prospects for Social Security introduce a paradox. A lower probability of Social Security surviving implies Social Security wealth is lower. Given a specific asset mix decision rule for the expanded portfolio, this implies a smaller equity allocation in the financial portfolio since the expanded portfolio has less fixed income. However, less Social Security wealth also reduces the size of the expanded portfolio—suggesting a need for more equity to grow the portfolio to meet future cash flow needs. We focus on first-order strategic asset allocation implications under asset mix decision rules. Expanding the analysis to include a liability representing future cash flow needs is left to future work.

Putting aside questions about Social Security's future, this analysis creates arguments for adding stock to the asset mix. For some investors, bonds are comforting—to the potential detriment of their portfolio. The similarity between inflation-indexed Social Security payments and inflation-indexed TIPS payments is simple and persuasive. The idea of an expanded portfolio (with comforting bond-like Social Security wealth) encourages and enables increased stockholdings to achieve target asset allocations.

There are many other possible extensions to this investigation. We ignore a range of additional nonretirement Social Security benefits; including them would only increase the value of Social Security. One could extend the analysis to reflect the probability of outliving the actuarial life expectancy. We assume couples were the same age and used gender-neutral actuarial tables. We make several simplifying assumptions related to considering only a high earner who receives maximum Social Security benefits, but Social Security's social insurance aspects favor low and middle earners. If private savings is proportional to income, the portfolio impact for low and middle earners will be even greater than the dramatic impact we show for high earners. All of these impacts could be quantified in detail; instead, we briefly consider gender, income-level and retirement-age in the Appendix. However, the point of this paper is to demonstrate a method of quantifying Social Security wealth and demonstrate its portfolio impact; rather than attempt to accommodate infinite variations, we suggest that our method be applied to an individual's specific circumstances.

To be realistic, the dual prescriptions of this paper—accurately valuing Social Security wealth and then integrating that wealth into asset mix decisions—will most likely be implemented by financial educators or financial planners. We agree with Kritzman (1992) that "the key challenge. . . is to present asset allocation (to individuals) in a way that appeals to an individual's intuition without compromising the integrity of the analysis." As stated above, we find the parallel between Social Security payments and inflation-indexed treasury bond coupon payments to be intuitive and persuasive. We hope that this intuition on valuing and integrating Social Security wealth will aid financial planners and educators to better implement rigorous asset allocation decisions with their clients or students.

Acknowledgments

The opinions included are those of the authors and not necessarily those of the US Air Force Academy, the US Air Force or any other federal agency. We anticipate maintaining related materials at *www.williamjennings.com.* We are grateful to Vickie Bajtelsmit, Tim Burch, Conrad Ciccotello, Karen Lahey (the editor), Bill Reichenstein, C. E. Steuerle, participants at the 2000 Academy of Financial Services conference in Seattle, and four anonymous reviewers for their input to this project.

Appendix A. Generalized results

We can generalize qualitative aspects of our results. Our base case analysis made certain assumptions about gender, income levels, and the retirement age decision; here, we demonstrate the dramatic impact of including Social Security wealth in an expanded portfolio for men, women, middle-income workers, and those that retire at age 65. We consider each permutation separately and examine its impact on fifty-year-old workers. Because of data availability, we use 1999 information in this Appendix. Without loss of generality, we focus on the 60/40 (stocks/bonds) fixed mix decision rule. All of our other assumptions remain unchanged.

A.1. Gender impact

Given equal earnings, men and women have different Social Security wealth because their life expectancies differ. Since women have longer life expectancies, they have greater Social Security wealth. Women, therefore, will have a greater bond allocation than men in their expanded portfolio for any asset-mix decision rule. Panel A of Table 11 shows this gender impact. We use IRS gender-specific actuarial tables for life expectancies. (Note that life expectancies under these tables for pre-1986 annuities are not comparable to the more modern IRS gender-neutral actuarial tables; however, they do serve our purpose in this Appendix by allowing comparison between men and women.) The gender impact is greater for single individuals but is quite small even then. For fifty-year-old workers pursuing a 60/40 fixed mix, single women's expanded portfolio stock allocation is within 3% of men. For married couples, the difference is less than 1%. This result holds when we change our assumption of equal-age couples to a case when the nonworking spouse is ten years younger. Accommodating gender differences in life expectancy has minimal impact on our conclusion that Social Security wealth dramatically affects the asset mix decision.

A2. Income level impact

Given the same percentage savings rates, people with different income levels will have different asset allocation consequences of including Social Security wealth in their expanded portfolios. Income level affects both the amount of Social Security benefits and the size of financial portfolios. Individuals with different incomes have different expanded portfolio consequences because Social Security benefits are a concave function of income. Middle-income workers have proportionally more of their wages replaced by Social Security benefits than high-income workers do. Accordingly, middle-income workers have greater Social Security wealth relative to their financial portfolios; thus, they will have a greater bond allocation than high-earners in their expanded portfolio for any asset-mix decision rule. Note that using the high-income worker as our base case was a conservative assumption since it reduced the impact of Social Security wealth on the expanded portfolio.

We compare a $72,600 high-income worker with a $36,456 middle-income worker. The $36,456 amount reflects someone earning 160% of the national average wage in 1999 and is approximately one-half the high-earner income. Given equal percentage savings, financial

Table 11
Implications of a 60/40 mix in the financial portfolio for the expanded portfolio

Demography			Perceived financial portfolio		Resultant expanded portfolio including Social Security wealth							
					5% Saver		10% Saver		15% Saver		MND Saver	
			Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds	Stocks	Bonds
Panel A: Gender Impact												
Age	Status	Gender										
50	Single	Male	60%	40%	39%	61%	47%	53%	51%	49%	49%	51%
		Female	60%	40%	36%	64%	45%	55%	49%	51%	47%	53%
		$M - F\ \Delta$			2.7%	−2.7%	2.0%	−2.0%	1.6%	−1.6%	1.8%	−1.8%
	Spouse is 50	Male	60%	40%	29%	71%	39%	61%	44%	56%	42%	58%
		Female	60%	40%	29%	71%	39%	61%	44%	56%	41%	59%
		$M - F\ \Delta$			0.8%	−0.8%	0.7%	−0.7%	0.6%	−0.6%	0.7%	−0.7%
	Spouse is 40	Male	60%	40%	28%	72%	38%	62%	43%	57%	40%	60%
		Female	60%	40%	27%	73%	38%	62%	43%	57%	40%	60%
		$M - F\ \Delta$			0.4%	−0.4%	0.3%	−0.3%	0.3%	−0.3%	0.3%	−0.3%
Panel B: Income Impact												
Age	Status	Income										
50	Single	$72,600	60%	40%	34%	66%	44%	56%	48%	52%	46%	54%
		$36,456	60%	40%	26%	74%	36%	64%	42%	58%	39%	61%
	Married	$72,600	60%	40%	27%	73%	37%	63%	43%	57%	40%	60%
		$36,456	60%	40%	19%	81%	29%	71%	35%	65%	31%	69%
Panel C: Retirement Age Impact												
Age	Status	Retire at										
50	Single	62	60%	40%	39%	61%	47%	53%	51%	49%	49%	51%
		65	60%	40%	35%	65%	44%	56%	48%	52%	46%	54%
	Married	62	60%	40%	28%	72%	38%	62%	43%	57%	40%	60%
		65	60%	40%	27%	73%	37%	63%	42%	58%	39%	61%

Expanded portfolio stock/bond mix resulting from adding Social Security wealth to a financial portfolio with a 60/40 fixed mix. Social security wealth is treated as a bond and uses values from Table 1 computed using real TIPS yields for a high-earning worker. Savings rates are applied over a working lifetime to create financial portfolio values; MND saver's financial portfolios are computed for "prodigious accumulator[s] of wealth" per Stanley and Danko (1996).

portfolio values will also be approximately one-half those of the high earner. Their Social Security benefits, however, will be substantially greater than one-half those of the high earner. According to the Social Security web site (1999), this middle-income worker can expect a PIA of $1,231, or about 90% of the high-earner's maximum PIA. Note that using the high-earner as our base case was a conservative assumption since it reduced the impact of Social Security wealth on the expanded portfolio. Panel B of Table 11 shows this income impact. For fifty-year-old workers pursuing a 60/40 fixed mix, the middle-income expanded portfolio stock allocation is within 9% of the high-income allocation. The impact would be greater still upon adding the value of the tax shield on Social Security benefits for low- and middle-income brackets. While this quantitative difference is economically significant, it does not affect our qualitative conclusion that Social Security wealth has a dramatic impact on asset allocation. It does encourage using individual-specific valuations as discussed in section 5.

A3. Retirement age impact

All else equal, people planning on waiting until age 65 to draw Social Security will have different asset allocation consequences of including Social Security wealth in their expanded portfolios than those that start at age 62. Retirement age affects both the amount of Social Security benefits and the size of financial portfolios. Waiting to retire will reduce the early retirement penalty and increase the financial portfolio; however, waiting decreases the expected duration of receiving benefits. Given all of our assumptions, retiring at age 65 implies greater Social Security wealth than retiring at age 62. Those that retire at age 65 have greater Social Security wealth relative to their financial portfolios; thus, they will have a greater bond allocation than those retiring at age 62 in their expanded portfolio for any asset-mix decision rule. Note that using the worker retiring at age 62 as our base case was a conservative assumption since it reduced the impact of Social Security wealth on the expanded portfolio. We also believe it a more likely scenario for the reasons discussed in section 3.3. Panel C of Table 11 shows the retirement age impact. For fifty-year-old workers pursuing a 60/40 fixed mix, the delayed-retirement expanded portfolio stock allocation is within 4% of the early-retirement allocation. Accommodating retirement age differences has minimal impact on our conclusion that Social Security wealth has a dramatic impact on asset allocation.

A4. Summary of generalized results

As with the base case discussed in the body of the paper, the generalized results demonstrate the dramatic impact of including Social Security wealth in an expanded portfolio. All else equal, gender differences and retirement-age differences had minimal impact on the strategic asset allocation. Because Social Security replaces more income for lower income workers, income differences affect the asset mix decision more than gender or retirement-age differences. Even with income differences, the stock allocation was within 9% of the high-earner base case in the body of the paper. Note, crucially, that because Social Security replaces more income for lower income workers, excluding Social Security wealth is a bigger error for them. Thus, focusing on high-earners in the body of the paper is conservative—it understates the case for including Social Security wealth. In short, none of the generalized results affects the conclusion that Social Security wealth has a dramatic impact on asset allocation and should be included in strategic asset allocation.

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